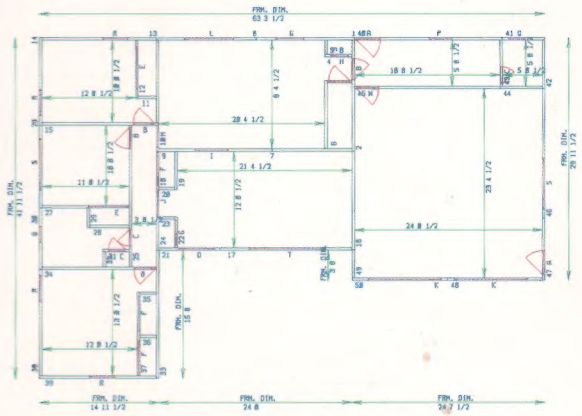
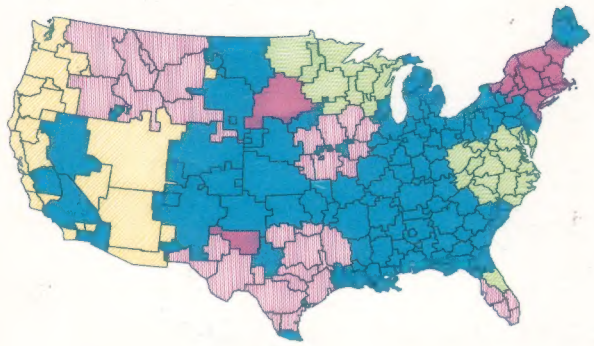
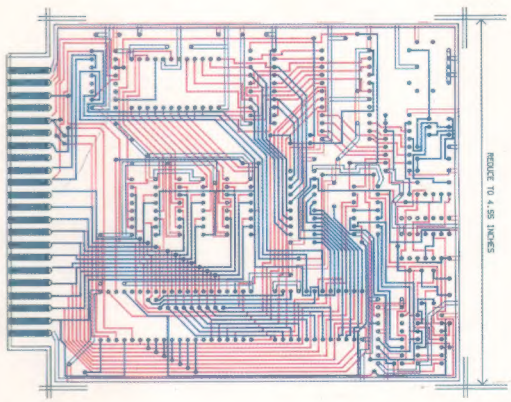
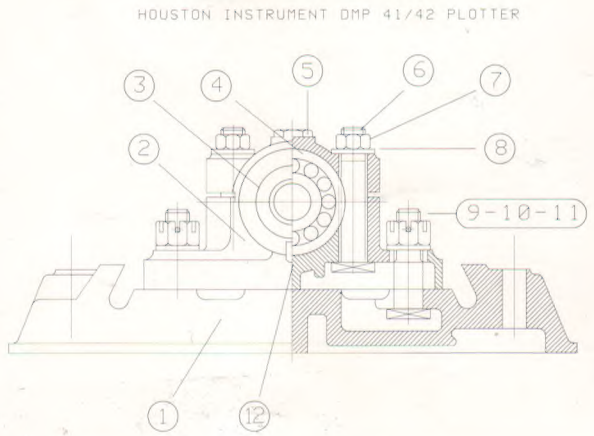
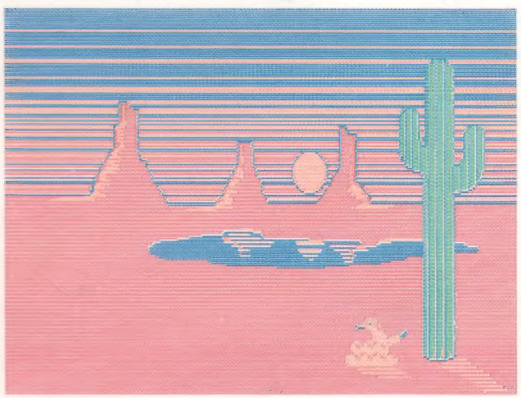
DM/PL™
COMMAND LANGUAGE

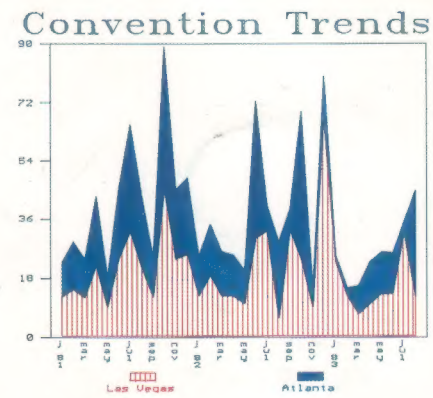












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SECTION 1
GENERAL INFORMATION

1.1 INTRODUCTION

Digital Microprocessor/Plotting Language (DM/PL™) is the command structure/protocol, or language, that your plotter understands. DM/PL and your plotter's internal microprocessor not only enable you to create complex graphs with simple commands, but relieves your computer from most of the software burden normally required for plotting activity. How? Houston Instrument has programmed your plotter with the "building" instructions for the most sophisticated graphic designs, such as circles, arcs, curves, and ellipses, and all you have to do is specify the design that you want and the dimensions for its size and the plotter does the rest!

Because DM/PL is compatible with languages such as BASIC, PASCAL, and FORTRAN, you can use this protocol with virtually any host computer system. DM/PL also provides you with two selectable modes for handshaking operations—Mode One, which enables you to use XON/XOFF handshake sequences with your system, and Mode Two, which enables you to program handshaking operations with your software. (You'll be reading more about these two modes in Section 1.2.)

Although DM/PL provides you with the means to produce wonderful charts and graphs on your computer and plotter system, you must first learn how to use this protocol with your computer's software, and then experiment with it to develop the programs that will best satisfy your plotting needs. (Appendix C provides sample plotter programs).

1.2 DM/PL HANDSHAKE SELECT MODES

The term "handshaking" simply means an agreement between the computer and the plotter on how they will signal each other to control the flow of data when a program is run. To initiate a handshake mode and a plotting session, the plotter must be "selected" by computer command. The two DM/PL handshake select commands are called Mode One Select and Mode Two Select. To terminate a handshake mode and a plotting session, the plotter must be "deselected" by computer command. This command is called the DM/PL Deselect command. These three commands are explained in the following paragraphs.

1.2.1 Mode One Select

Format: ;:zzz...

;: is the Mode One Select command.

zzz... are plot codes.

Mode One enables the plotter and the host computer to communicate with a handshake operation called "XON/XOFF." XON/XOFF was initially developed for teletype communications and is now a commonly used protocol for computer systems.

Although Mode One requires very little in the way of handshaking, it does require XON (DC1)/XOFF (DC3) capability in the host computer. XON is the ASCII teletype Device Control code one (11_{16}), and XOFF is the ASCII teletype Device Control code three (13_{16}). To determine whether or not your computer supports Mode One (XON/XOFF), consult your computer owner's manual.

Figure 1-1 illustrates how Mode One operates. During a plotting session, the computer transmits plot data to the plotter at a faster rate than the plotter can process it. Thus, the unprocessed data fills the buffer to its maximum capacity. When the buffer reaches its maximum, the plotter sends the XOFF (DC3) signal to the host computer and sets the ready for data (RFD) line low, which tells the computer to stop transmitting data. The host computer then stops the data flow, and the buffer drains as the plotter processes the buffer data. When the buffer has room for more data, the plotter sends

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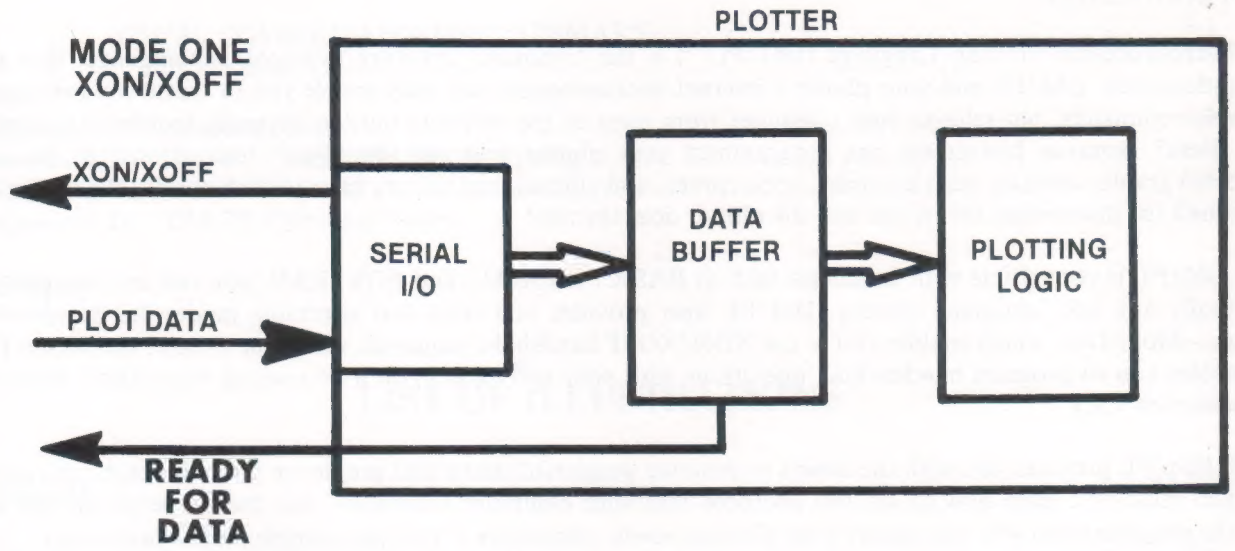
the XON (DC1) signal to the host and sets the RFD line high, which tells the host to resume the data transmission. This sequence of events continues until all of the data from the host computer has been transmitted to the plotter.



When the buffer is full, the plotter sends XOFF and sets the ready for data line low. When the buffer is ready for more data, the plotter sends an XON and sets the ready for data line high.

FIGURE 1-1
MODE ONE (XON/XOFF)

A Mode One Select (;:) command designates Mode One operation. This command must appear at the beginning of the first data string. After the plotter receives a Mode One Select command, it operates in Mode One until it is issued a Deselect or a Mode Two Select command, or until the plotter is reset or powered down.

To switch the plotter from Mode Two to Mode One, first reset the plotter, and then issue a Mode One Select (;:) command.

Example of a Mode One command string: ;:T

;: is the Mode One Select command.

T is the Plotter Test command.

1.2.2 Mode Two Select

Format for Mode Two Select:

;:I *pc d,*

;:I is the Mode Two Select command.

pc is the prompt code your computer sends to the plotter to ask if space is available for data transmission. *pc* is a single ASCII character specified by a two-digit hexadecimal number (e.g., <CR> is $0D_{16}$). (Both digits must be included.)

d is the delay time that you want the plotter to wait before sending its response code to the computer after it receives the prompt code (*pc*). *d* is a numeric expression between 0 and 255. Each numeric increment equals 1/100 second. A numeric delay time specifier must be entered.

Format for Mode Two Select with optional plotter response code specifiers:

;:I(*nn nn nn nn*) *pc d,*

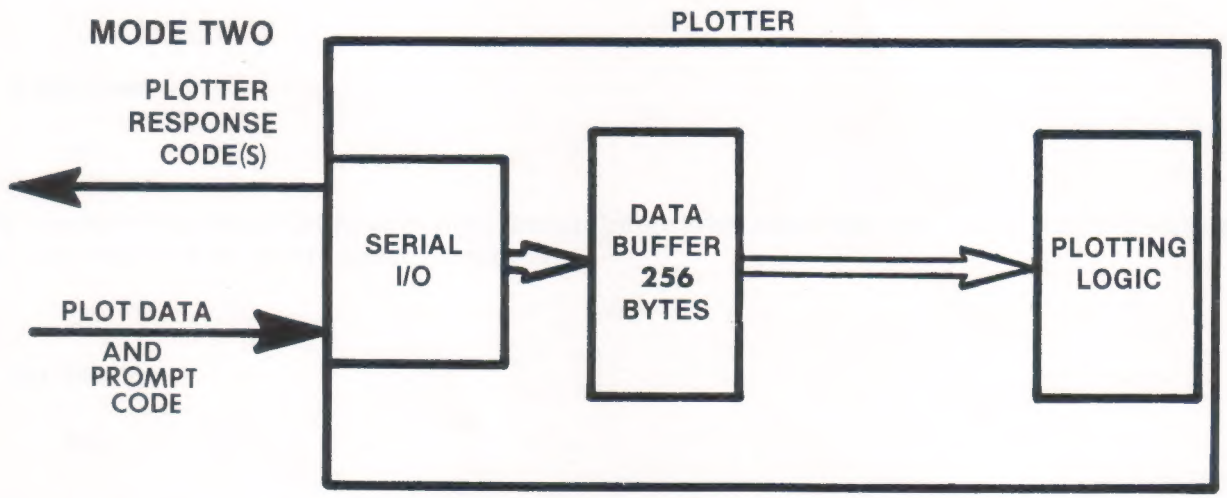
(*nn nn nn nn*) are additional plotter response codes that you may use with the Mode Two Select command. These codes are optional and if omitted, the plotter responds with its default response code of a single carriage return <CR> ($0D_{16}$). If the option is used, you can specify a response code consisting of one, two, three, or four ASCII characters by entering their two-digit hexadecimal values (e.g., 1_{ASCII} is 31_{16}).

NOTE

If you select the plotter for Mode One (;:) operation, you can switch to Mode Two operation without having to deselect or reset by entering, I *pc d,* or I (*nn,nn,nn,nn) pc d,* (without the preceding ;:). However, after Mode Two is selected, you cannot return to Mode One operation without first resetting the plotter.

Mode Two establishes a type of data control link between the host computer and the plotter that enables the computer to ask the plotter if there is room in its buffer for up to 256 additional characters.

When your system is operating in Mode Two, the computer sends the specified prompt code (*pc*) to the plotter which asks the plotter to respond when buffer space is available. The plotter waits the specified delay time (*d*) before checking its buffer status. The delay time is to ensure that the plotter does not respond too quickly for the computer to receive its response. After the delay time has expired, the plotter then checks its buffer. If there is enough room for 256 additional characters, the plotter responds with either its single <CR> default response code character or with the optional user-specified response code(s). After the computer receives the response code(s), you may send up to 256 new characters to the plotter, and then repeat the process. Figure 1-2 illustrates data flow in Mode Two.



When the prompt code is received, the plotter waits for the programmed delay to expire. Then, when there is room for 256 bytes in the buffer, the plotter sends its response code(s).

FIGURE 1-2
MODE TWO DATA FLOW

1.2.3 Deselect

Format: @

The Deselect command takes the plotter off-line. After the plotter receives the command, it continues to process the data that is already in the buffer and will not accept new data until it is selected again. The Deselect command does not affect any of the plotter's parameters, such as the resolution, window size, etc. After the plotter is deselected, the data passes through the plotter's pass-through port causing the plotter to appear transparent in the computer configuration.

NOTE

The Deselect (@) command cannot be used to switch the plotter from Mode Two to Mode One. If the plotter is operating in Mode Two when it is deselected, it must be reset to operate in Mode One.

SECTION 2
DM/PL COMMAND DESCRIPTIONS

2.1 PLOT SETUP COMMANDS

The DM/PL plot setup commands are:

- Small Chart (EH)
- Large Chart (EF)
- Set Velocity (V)
- Set Window/Viewport Limits (W)
- Prompt Enable (EB)
- End of Text (ET)
- Frame Advance (F)

2.1.1 Small Chart

EH

The EH command sets the plotter to small chart format. Information about how your plotter performs in small chart format is provided in your plotter operator's manual.

2.1.2 Large Chart

EF

The EF command sets the plotter to large chart format. Information about how your plotter performs in large chart format is provided in your plotter operator's manual.

2.1.3 Set Velocity

V*n*,

n specifies the velocity of the plotter. If the current Coordinate Addressing (EC) command is set for .001 inch or .005 inch, then the units for *n* are measured in inches per second. If the current EC command is set for .1 mm or .025 mm, then the units for *n* are measured in centimeters per second. (The Coordinate Addressing command is explained in Section 2.2.3.)

The Set Velocity command enables you to change the velocity of the pen (down position travel). The velocity of the pen is changed when a different number is specified for *n* in the V command format. For example, if the plotter is operating at a velocity of 2 ips and receives a V3 command, the plotter then plots at a velocity of 3 ips. Refer to the plotter's operator's manual for its velocity capabilities.

2.1.4 Set Window/Viewport Limits

W *wxll, wyll, wxur, wyur, vpxll, vpyll, vpxur, vpyur*

wxll, wyll specifies the lower left window limit coordinate.

wxur, wyur specifies the upper right window limit coordinate.

vpxll, vpyll specifies the lower left viewport limit coordinate.

vpxur, vpyur specifies the upper right viewport limit coordinate.

The W command enables you to set or change the plotter's window and viewport limit coordinates with your software program. After a W command is entered, it remains in effect until a new W command is issued or until the limits are changed manually (from the control panel), or until the plotter is reset. The limits default to the entire plotting surface if the plotter receives an illegal parameter in a W command, or if a new Coordinate Addressing (EC) command is issued, or if the plotter is reset or powered down.

The default window for the plotter is the maximum plot size for the chart size presently in effect.

The window tells the plotter what portion of a plot to reproduce by specifying a rectangular area using the lower left and upper right points (see Figure 2-1). The window provides the plotter with "clipping" capabilities. In plotter terminology, clipping is the ability to select a part of a complete plot design for reproduction. When the plotter is commanded to draw a clip from a plot design or during the actual processing of the clip, the pen may pause for various lengths of time. The reason for the pause is that when window limits are specified, the plotter still receives the plot codes for the entire plot design but processes only the data for the plot that was placed inside the limits. If the data for the window plot is not at the beginning of the program, the pen must wait until that portion of the program is received by the plotter. If the plotter is processing window data and receives plot codes that require the pen to travel outside the limits, the pen processes up to the limit and then pauses. The pen resumes processing when the plotter receives additional data inside the window. The size of the window is not limited to the size of the plotter.

The viewport specifies an area for the plotter to reproduce the current window limit's plot data. For instance, if you place window limits (*wxll, wyll, wxur, wyur*) around a particular area on a plot, then that data can be reproduced at the location specified by the viewport limits (*vpxll, vpyll, vpxur, vpyur*). If the area within the viewport limits is equal to the area within the window limits, the size of the reproduction will be equal to the size of the original. If the area within the viewport limits is made less than the area of the window, then the reproduction will be scaled down, and vice-versa. If the viewport limits are not set in proportion with the window limits, the aspect of the plot can be changed. (Figures 2-2a, 2-2b, and 2-2c show different aspect changes.) When the limits for the viewport are specified larger than the plotting surface of the plotter, the window and viewport are set to default values.

When specifying the parameters of the W command, you must consider the addressing units you are currently using (EC1, EC5, etc.), and remember that the units you specify are relative to the fixed origin of the current chart size format (EH or EF).

The ER command may be used to examine the current window and viewport settings (see Section 2.9.1).

NOTE

When the window and viewport limits are downloaded, the function of the viewport is essentially the same as the scale box function when the limits are set manually (see your plotter operator's manual for these instructions).

Example: ;:H A W 200,200,1000,1000,200,200,1000,1000,

In this example:

1. The plotter is selected (;:).
2. The pen moves to Home Position (H).
3. Absolute Pen Positioning is specified (A).
4. 200,200 is specified as the lower left limit coordinate, and 1000,1000 is specified as the upper right limit coordinate for both the window and the viewport (W).

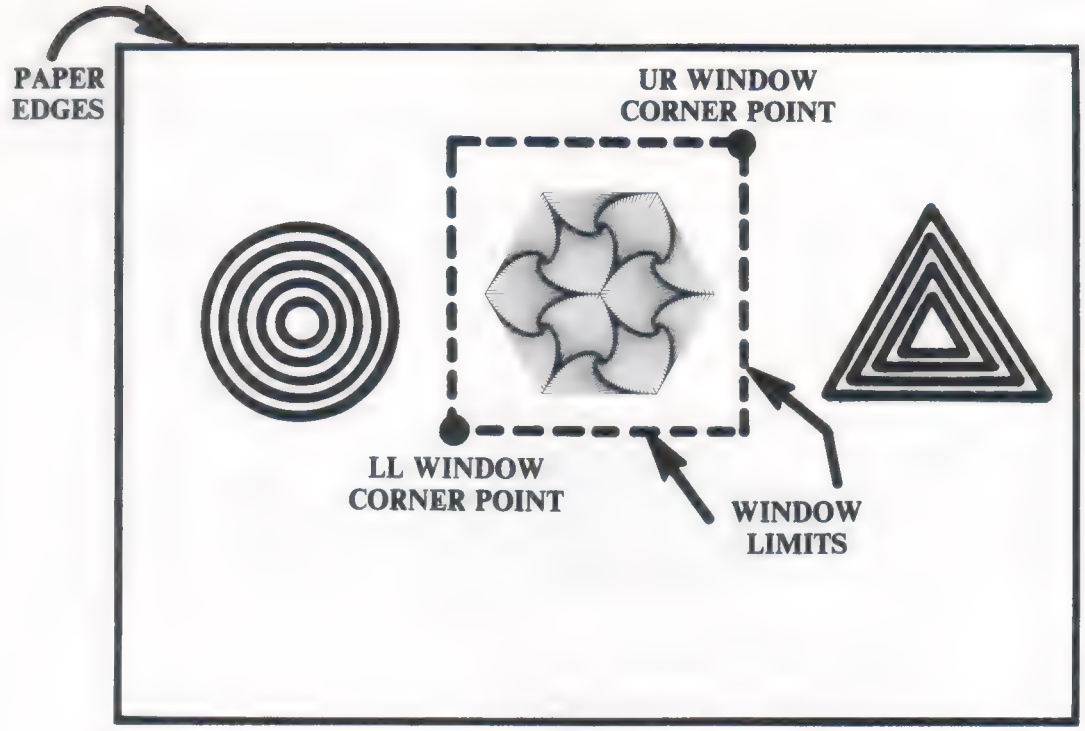


FIGURE 2-1
WINDOW LIMITS AROUND A SUBPART OF A PLOT DESIGN

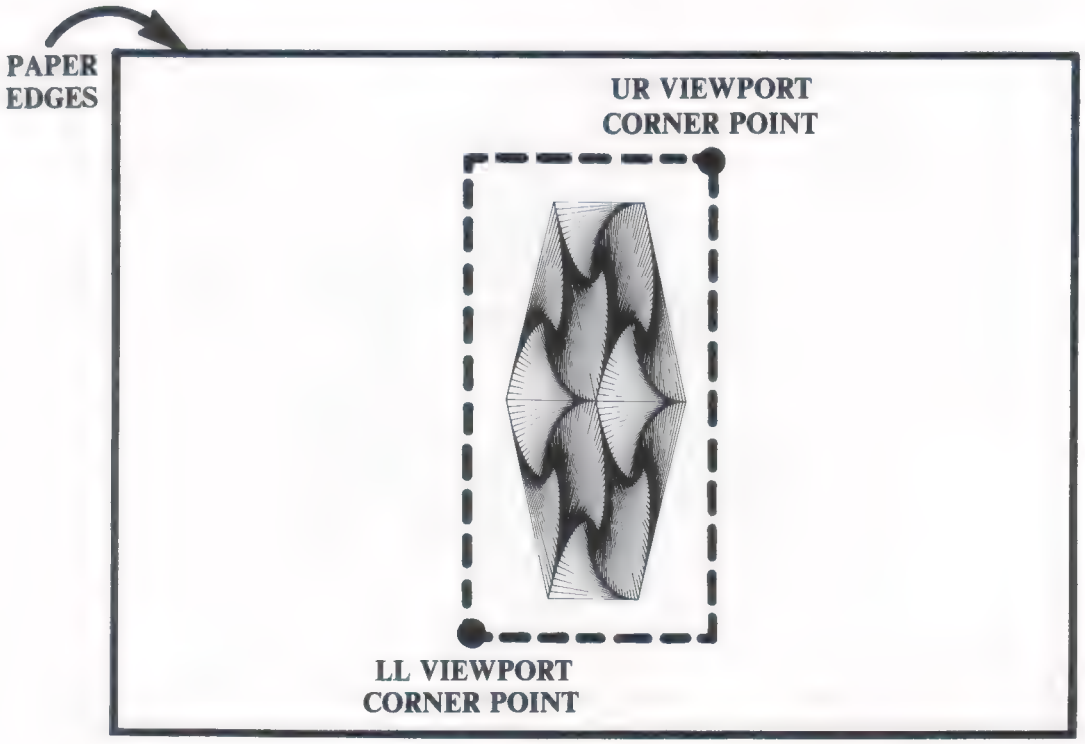


FIGURE 2-2a
A VIEWPORT THREE TIMES THE HEIGHT OF THE WINDOW

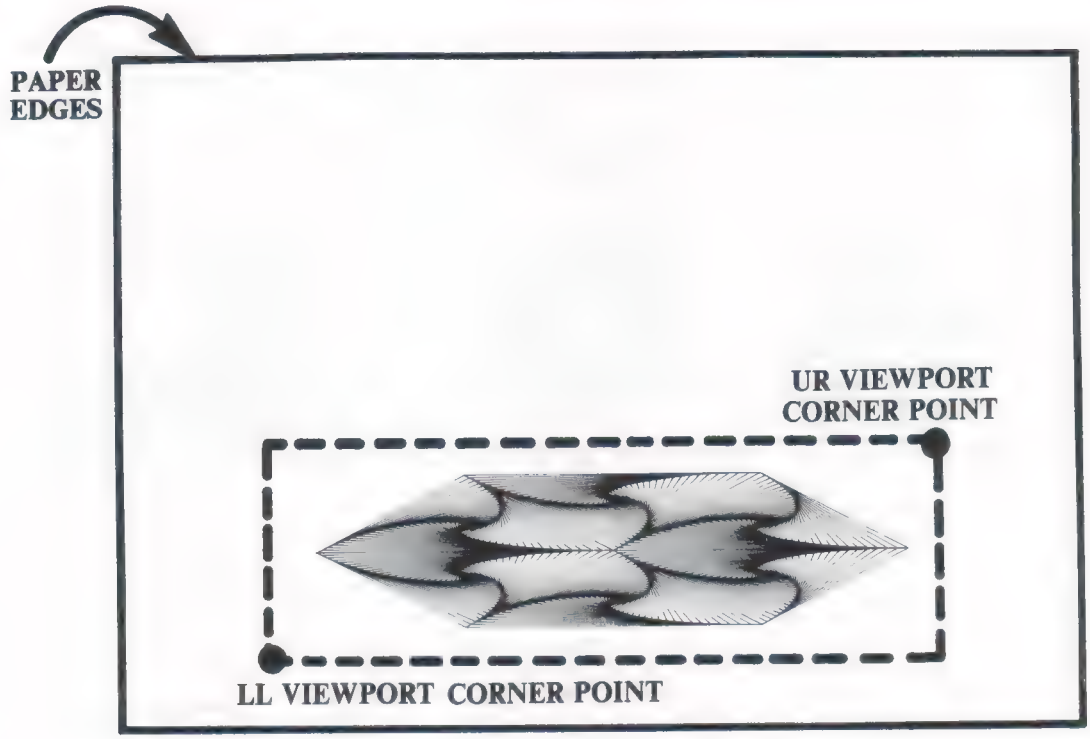


FIGURE 2-2b
A VIEWPORT THREE TIMES THE LENGTH OF THE WINDOW

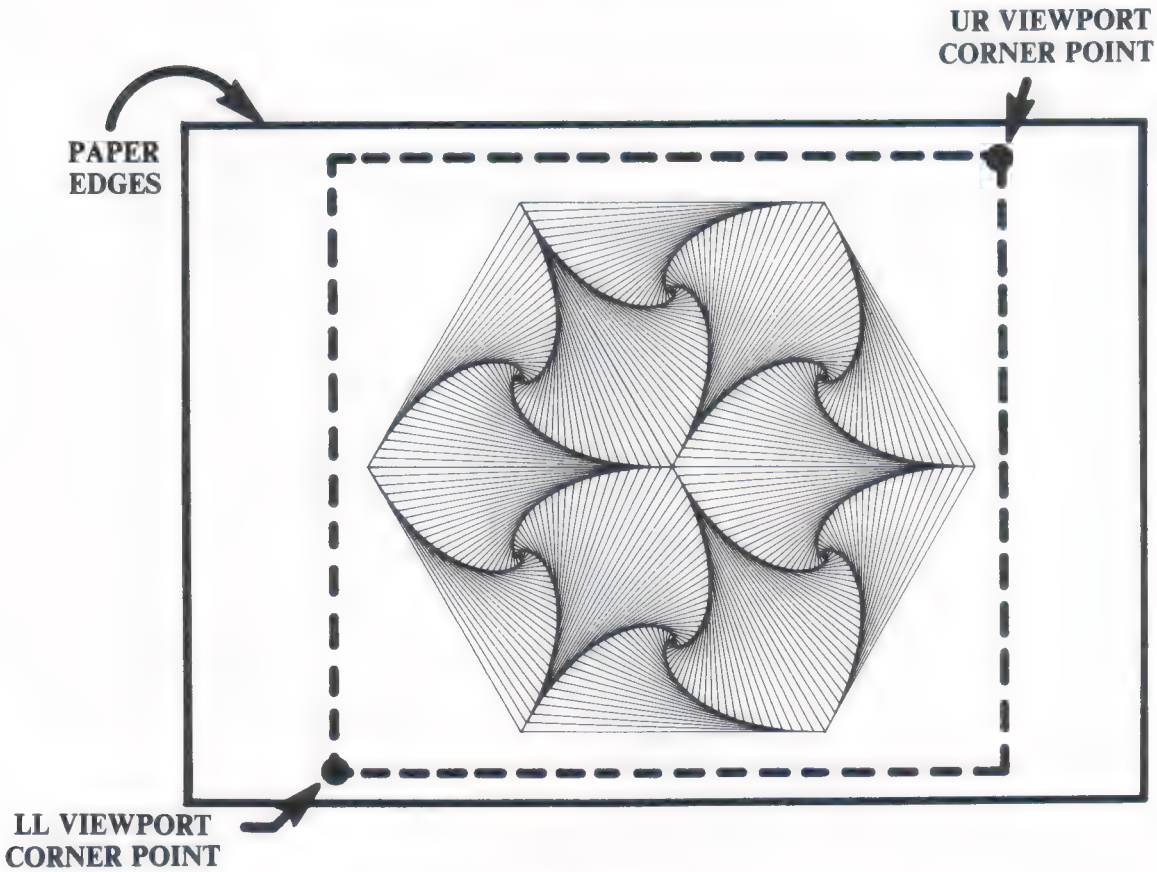


FIGURE 2-2c
A VIEWPORT THREE TIMES THE HEIGHT/LENGTH OF THE WINDOW

2.1.5 Prompt Enable

EB*nn*,

nn is the two-digit hexadecimal value of the character that you want to use as a prompt enable indicator when plotting in a text mode. The default value for *nn* is a caret ($5E_{16}$ or 94_{10}).

The EB command provides you with more flexibility while plotting in Mode Two. It allows prompting inside of a text string when you are in either Simple Text mode (see Section 2.6.1) or Extended Text mode (see Section 2.6.2). The prompt enable character is used to distinguish a prompt character from a text character. If you want to send a prompt inside of a text string, first send the prompt enable character, followed by the prompt character. If the prompt is not preceded by the prompt enable character, then the prompt will be interpreted as a text character and not as the prompt character.

The default prompt enable character is a caret ($5E_{16}$) (94_{10}), however, you can specify another character as the prompt enable by using the Prompt Enable (EB) command. The EB command must be entered immediately after the Mode Two select sequence. Otherwise, the plotter will not recognize the character you selected for the new prompt enable and will process only the EB command's default value (caret). To specify a different prompt enable character, enter the character's two-digit hexadecimal value immediately following the EB command. After an EB command is entered, it remains effective until another EB command is entered during a Mode Two select sequence, or until the plotter is powered down.

Example: ;:I0D 100,EB7E,

In this example, the plotter is selected for Mode Two (;:I), and a carriage return ($0D_{16}$) prompt code and a one second delay time (100) are specified. Immediately following the Mode Two select sequence, a tilde ($7E_{16}$) character is specified as the prompt enable indicator (EB).

NOTE

Do not specify the Mode Two prompt, the Deselect (@), or the End of Text (ET) character as a Prompt Enable (EB) indicator.

2.1.6 End of Text

ET*nn*,

nn is the two-digit hexadecimal value of the character that you want to use as the end of text indicator. The default value for *nn* is an underscore ($5F_{16}$ or 95_{10}).

The ET command enables you to change the end of text indicator used in Simple Text (see Section 2.6.1) and Extended Text (see Section 2.6.2) to another character. The default end of text character is an underscore ($5F_{16}$).

To specify a different character for the end of text indicator, enter the character's two-digit hexadecimal value immediately following the ET command. An ET command is effective only if it is preceded by a Mode Two select sequence. After a character is specified by an ET command, it remains the end of text indicator until another ET command is entered preceded by a Mode Two select sequence, or until the plotter is powered down.

NOTE

Do not specify the Mode Two prompt, the Deselect (@), or the Prompt Enable (EB) character as an End of Text (ET) indicator.

2.1.7 Frame Advance

F*n*,

n is the number of user units between the current home position and the new home position.

The Frame Advance (F) command is used to advance the paper between plots on plotters that are equipped with the roll chart option or continuous feed mechanisms. This command advances the paper by establishing a new home position. (The Home Position command is discussed in Section 2.2.4.) The location of the new home position is determined by the number of units used for *n* in the Frame Advance command. Your operator's manual provides the number of units you should use on your plotter.

When the plotter processes a Frame Advance command, the pen lifts to up position and then moves to the new home position. The fixed and current origin is then set to the new home position.

If the plotter is in large chart:

Y new home = Y current home = 0

X new home = X current home + *n*

If the plotter is in small chart:

X new home = X current home = 0

Y new home = Y current home + *n*

If the plotter is in large chart and *n* is specified as 0:

Y new home = Y current home = 0

X new home = current X position

If the plotter is in small chart and *n* is specified as 0:

X new home = X current home = 0

Y new home = current Y position

2.2 ADDRESSING COMMANDS

The DM/PL addressing commands are:

- Absolute Pen Positioning (A)
- Relative Pen Positioning (R)
- Coordinate Addressing (EC)
- Home Position (H)
- Set Plot Origin (O)

2.2.1 Absolute Pen Positioning

A

The Absolute Pen Positioning (A) command selects the Absolute Addressing Mode. In this mode, all x,y positions are relative to the current Origin (see Set Plot Origin in Section 2.2.5). The plotter remains in this mode until it receives a Relative Pen Positioning (R) command (see Section 2.2.2) or a Reset (Z) command (see Section 2.10.2).

NOTE

Absolute or Relative Addressing Mode must be specified before the plotter will process vector commands.

Example: ;:HAD 0,600,600,600,600,0,0,0,U

The plotter's actions are:

1. The plotter is selected (;:).
2. The pen moves to Home Position (H).
3. Absolute Pen Positioning is specified (A).
4. The pen is lowered to the plotting surface (D).
5. The pen is moved to absolute coordinate 0,600.
6. The pen is moved to absolute coordinate 600,600.
7. The pen is moved to absolute coordinate 600,0.
8. The pen is moved to absolute coordinate 0,0.
9. The pen is raised from the plotting surface (U).

2.2.2 Relative Pen Positioning

R

The Relative Pen Positioning (R) command selects Relative Addressing Mode. In this mode, all x, y positions are relative to the current user position. (The user position may differ from the pen position where DM/PL Curve commands are specified.) The plotter remains in this mode until it receives an Absolute Pen Positioning (A) command or a Reset (Z) command.

NOTE

Absolute or Relative Addressing Mode must be specified before the plotter will process vector commands.

Example: ;:H R EC5,D 0,600,600,0,0, – 600, – 600,0,U

This command string will plot a box about three inches in size using relative vectors rather than absolute vectors. Here is the sequence:

1. The plotter is selected (;:).
2. The pen is moved to Home Position (H).
3. Relative Pen Positioning is specified (R).
4. Coordinate addressing is specified for .005 inch (EC).
5. The pen is lowered to the plotting surface (D).
6. The pen is moved 0 steps in the x direction, 600 steps in the y direction from Home Position (R).
7. The pen is moved 600 steps in the x direction, 0 steps in the y direction (relative to the last achieved position—0,600) (R).

8. The pen is moved 0 steps in the x direction, 600 steps in the −y direction (relative to the present position—600,600) (R).

9. The pen is moved 600 steps in the −x direction, 0 steps in the y direction (relative to the present position—600,0) (R).

10. The pen is raised from the plotting surface (U).

NOTE

A Pen Down (D) command was given to produce the line. The pen referenced coordinate 0,0 (H) to move to the first coordinate point in the example (0,600). Each move thereafter was based on the preceding coordinate point.

2.2.3 Coordinate Addressing

EC*n*,

n selects the user addressability, and is an alphanumeric expression 1, 5, N, or M. *n* must be specified.

The Coordinate Addressing (EC) command enables you to set user units equal to .001 inch, .005 inch, .025 mm, or .1 mm. The command specifiers are listed in Table 2-1. After an EC command is entered, the user addressability remains in effect until it is changed, or until the plotter is reset or powered down. When the plotter receives an EC command, it moves the pen holder to home position and sets the window to the current chart size.

TABLE 2-1
COORDINATE ADDRESSING

CODE (*n*)	ADDRESSABLE RESOLUTION
1	.001 inch
5	.005 inch
M	0.1 mm
N	0.025 mm

Example: EC5,

This command sets the plotter addressing to one user unit = .005″.

2.2.4 Home Position

H

This command tells the plotter to raise the pen from the plotting surface and move to the home position (fixed coordinate 0,0). The home position is defined as the most lower left corner of the plotting area as selected by the Small Chart (EH) or Large Chart (EF) command. Any previously selected Absolute (A), Relative (R), or Line Type (L) command is retained except Set Plot Origin (O). The current origin is then set equal to the position of home.

2.2.5 Set Plot Origin

O

When the plotter processes a Set Plot Origin (O) command, it specifies the current user position as the "origin" of the Absolute (A) plotting coordinate system. It may be used at any time. The new origin is then retained until the plotter processes a Home Position (H) or Reset (Z) command. The origin thus becomes absolute coordinate 0,0.

2.3 PEN CONTROL COMMANDS

The DM/PL Pen Control Commands are:

- New Pen (P)
- Pen Down (D)
- Pen Up (U)

2.3.1 New Pen

P*n*,

n is an integer used to select the desired plotter pen. *n* must be specified.

The New Pen (P) command enables you to make multi-colored plots and graphs. If a P0 command is entered, the plotter will lift the currently used pen from the plotting surface, return it to its pen stall, and move to home position. For other values entered for *n*, the plotter will return the currently used pen to its pen stall, and then retrieve pen number *n*. The current user position and pen status (up or down) are unchanged by this command. After the plotter receives a New Pen command, it resets the line type to a solid line (L0). (To change the pen number and the line type, enter the P command, followed by a Line Type command, and then the plot instruction.) If you have a single pen model, see the description of your plotter's Pen Pause feature in your operator's manual.

Example: ;:P2,T

This command:

1. Selects the plotter (;:).
2. Retrieves pen number two (P2,).
3. Draws the Self-Test plot design (T).

2.3.2 Pen Down

D

The Pen Down (D) command causes the plotter to lower the pen to the plotting surface. The pen remains in the down position until a Pen Up (U), Home Position (H), or Plotter Reset (Z) command is received by the plotter. The plotter automatically raises the pen from the plotting surface after several seconds of inactivity and returns the pen to the surface when plotting is resumed. This prevents the pen from "bleeding" on the paper during idle periods. A power loss to the plotter resets the pen to up position. (Also see the incremental pen down command in Section 2.5.2.)

2.3.3 Pen Up

U

The Pen Up (U) command causes the plotter to raise the pen from the plotting surface. The Pen Up command remains in effect until a Pen Down (D) command is executed. (Also see the incremental pen up command in Section 2.5.2.)

2.4 LINE CONTROL COMMAND

The DM/PL Line Control Command is:

- Line Type (L)

2.4.1 Line Type

L*n*,

n is the line type specifier (see Table 2-2).

The Line Type (L) command provides you with 11 different line types to use for your plots and graphs. The 11 specifiers and the line types are shown in Table 2-2. (If you have a PC Plotter model, see your operator's manual for its line types.)

After a line type is specified, it remains in effect until a new line type is specified, or a New Pen (P) command is entered, or the plotter is reset. (A reset and the P command cause the line type to default to L0.) To change both the line type and the pen color, enter the New Pen command first, immediately followed by a new Line Type command.)

TABLE 2-2
LINE TYPES

COMMAND	LINE TYPE DRAWN
L0	————
L1	
L2	.....
L3	----------
L4	- - - - - - - -
L5	— — — — — — —
L6	— — — — — —
L7	— · — · — · — · —
L8	— ·· — ·· — ·· —
L9	— · — · — · — · —
L:	— — —

2.5 MOVE COMMANDS

The DM/PL Move Commands are:

- Vector Move To Specified Coordinate (x,y,)
- Incremental Move

2.5.1 Vector Move To Specified Coordinate

x,y,

x,y, is the coordinate point that you want the plotter to move to. (Your operator's manual provides the coordinate range for *x,y*.)

This command causes the plotter to move its pen to a new user position specified by *x,y,*. This new position is dependent on the current Absolute (A) or Relative (R) Pen Positioning command. In Absolute (A) Mode, the new position is x,y user units from the currently set user origin (see Set Plot Origin command). In Relative (R) Mode, the new position is x,y user units from the current user position.

NOTE

The plotter ignores x,y vector moves if a pen positioning mode (A or R) has not been previously specified in your program.

2.5.2 Incremental Move

An incremental move command is a lower case alphabetical letter as shown in Table 2-3. For every incremental letter command received by the plotter, the pen moves one user increment. (The length of one user increment is determined by the current Coordinate Addressing EC command.)

TABLE 2-3
INCREMENTAL MOVE COMMAND CODES

LOWER CASE INCREMENTAL COMMAND LETTER	INCREMENTAL MOVE
p	+y
q	+x, +y
r	+x
s	+x, −y
t	−y
u	−x, −y
v	−x
w	−x, +y
y	Pen up
z	Pen down

2.6 TEXT COMMANDS

The DM/PL Text Commands are:

- Simple Text Mode (S)
- Extended Text Mode (S(<parameters>))

2.6.1 Simple Text

S*rhh*character string __

r specifies the degree of rotation and is a numeric expression between one and four: 1 = 0°, 2 = 90°, 3 = 180°, 4 = 270°.

hh specifies the height of the character. The nine height increments are expressed as 1 , 1+, 2 , 2+, 3 , 3+, 4 , 4+, and 5 . *hh* is a two-byte field. Height specifiers 1, 2, 3, 4, and 5 must be followed by a space. (Do not include a space after height specifiers 1+, 2+, 3+, or 4+ since the character following the two-byte field *hh* will be plotted.)

character string is the text to be plotted.

__ is an underscore ($5F_{16}$) (95_{10}) and is the default end of text indicator.

The S command causes the plotter to draw alphanumeric characters. The 93 printable ASCII characters (see Appendix A, 32—126 decimal) can be drawn in nine different sizes and rotated in four directions. Tables 2-4a and 2-4b show the heights available according to the user addressability presently in effect.

If a carriage return <CR> ($0D_{16}$) is placed within a text string, the plotter will move the pen back to the beginning of that text string. If a line feed <LF> ($0A_{16}$) is placed within a text string, the plotter will move the pen down one line the size of the specified character height.

TABLE 2-4a
ENGLISH UNIT CHARACTER SIZES

CODE NUMBER	CHARACTER SIZE (AT 0.005 INCH)	CHARACTER SIZE (AT 0.001 INCH)
1	0.07 inch	0.0014 inch
1+	0.105 inch	0.021 inch
2	0.14 inch	0.028 inch
2+	0.21 inch	0.042 inch
3	0.28 inch	0.056 inch
3+	0.42 inch	0.084 inch
4	0.56 inch	0.112 inch
4+	0.84 inch	0.168 inch
5	1.12 inch	0.224 inch

NOTE

The 1, 2, 3, 4, and 5 parameters must be followed by a space. Do not include a space after parameters 1+, 2+, 3+, or 4+.

TABLE 2-4b
METRIC UNIT CHARACTER SIZES

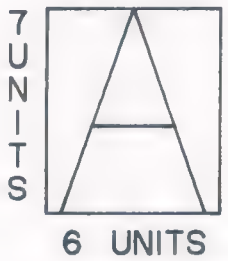
CODE NUMBER	CHARACTER SIZE (AT 0.1 MM)	CHARACTER SIZE (AT .025 MM)
1	0.14 mm	0.035 mm
1+	2.1 mm	0.52 mm
2	2.8 mm	0.70 mm
2+	4.2 mm	1.05 mm
3	5.6 mm	1.4 mm
3+	8.4 mm	2.1 mm
4	11.2 mm	2.8 mm
4+	16.8 mm	4.2 mm
5	22.4 mm	5.6 mm

NOTE

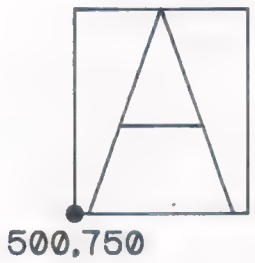
The 1, 2, 3, 4, and 5 parameters must be followed by a space. Do not include a space after parameters 1+, 2+, 3+, or 4+.

The exact placement of a Simple Text character (or the starting point for a Simple Text character string) is determined by a single x,y coordinate point. The plotter uses a common format of seven units (height) by six units (width) for the area

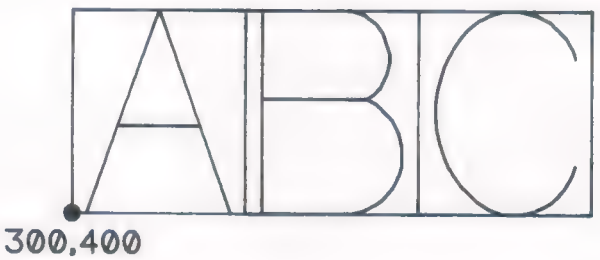
of a Simple Text character and centers the character in that area. (The size of the area is determined by the value of the height specifier in the Simple Text command and the current addressable resolution setting.) For example, the plotter sees the Simple Text character A as this:



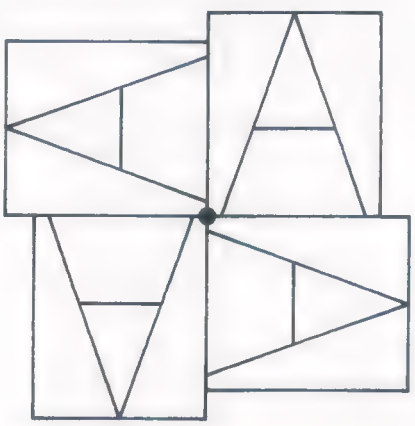
Where the plotter will draw a character (or start a character string) is determined by the coordinate value of the lower left corner point of the format area. For example, if you specify Simple Text character A at x,y coordinate 500,750, the plotter uses coordinate 500,750 as the lower left corner point for its (7 × 6 unit) format area as illustrated below.



In a character string, the x,y coordinate is the starting point for the text. The plotter draws the first character at that point, and then increments one (7 × 6 unit) format area for each character in the string. The example below is a text string consisting of Simple Text characters A, B, and C with a starting point coordinate value of 300,400.



If rotation (r) is specified, the plotter uses the x,y coordinate as the axis point of rotation.



The length of a character string can be calculated with the following formula:

$$\text{Length} = 6/7 \times \text{Height} \times \text{number of characters}$$

An underscore ($5F_{16}$) (95_{10}) indicates the end of the character string and terminates Simple Text mode. The underscore is the default end of text indicator. A different end of text character can be specified by entering the End of Text (ET) command (see Section 2.1.6) prior to Simple Text mode initiation. The current end of text character exits the plotter from Simple Text mode.

If you are operating the plotter in DM/PL Mode Two and want to send a prompt character in the middle of a character string, you must first send the prompt enable character. The default prompt enable character is a caret ($5E_{16}$) (94_{10}), however, you can specify most any character as the prompt enable character by using the Prompt Enable (EB) command prior to Simple Text mode initiation (see Section 2.1.5). If a prompt enable character is not sent before the prompt character, the prompt character will be interpretted as a text character and the plotter will not send the response codes.

Example:

10 LPRINT ";:I0D 0,H A 0,800,S13+ HOUSTON"; (caret) <CR>

20 LPRINT " INSTRUMENT"; (underscore) <CR>

In this example, the plotter is selected for Mode Two (;:I). The pen moves to home position (H). Absolute Addressing (A) is specified The pen moves 800 steps in the y direction (A). No rotation and character size 3+ are specified (S). The plot "HOUSTON" is drawn (S13+). The caret ($5E_{16}$) enables the first prompt code <CR> and the plotter handshakes. The plot "INSTRUMENT" is drawn following the plot "HOUSTON" (S13+). The underscore ($5F_{16}$) preceding the second prompt code <CR> indicates the end of the text string. The plotter exits Simple Text mode and handshakes. This example produces a plot that looks similar to this:

HOUSTON INSTRUMENT

If a character string requires new starting coordinates or a change of character height or rotation, then Simple Text mode must be exited at the last character string before the new parameters for the text are required. The new parameters can then be specified with a new Simple Text (S) command.

2.6.2 Extended Text

S(S*n*,W*n*,I/NI,G*n*, X*n*,Y*n*,) character string _

S, immediately followed (no space or comma) by a text parameter set enclosed in parentheses, places the plotter in Extended Text mode. Only the parameters you want changed have to be included in the command's text parameter set (). (The size and rotation parameters selected in Simple Text also apply to the Extended Text parameters.) After the parameter set is changed by the Extended Text (or Simple Text), the modified set can be recalled by entering, S().

Extended Text Parameters:

(S*n*,) specifies the height and width of the characters. *n* is a numeric expression between one and 255. The standard width ratio is 6/7 times the character's height. Height is *n* times .007″ at .001″ resolution, *n* times .35″ at .005″ resolution, *n* times 0.7 mm at 0.1 mm resolution, or *n* times 0.175 mm at 0.025 mm resolution.

Example: ...EC1,S(S10)... will make character height = .070″, and character width = .060″.

(W*n*,) specifies only the width of the character. (W*n*,) is used when non-standard aspect ratio is desired for the character. *n* is a numeric expression between 1 and 255.

Example: ...EC1,S(S10,W5,)... will make character height = .070″, and character width = .030″.

(I/NI) determines whether the subsequent text is italicized or non-italicized. If (I) is used, the text is italicized. If (NI) is used, the text is not italicized.

(G*n*,) selects the text character set for the character symbols. There are eight different character sets available. Examples of each character set and their respective codes are listed in Table 2-5. The default character set is G0 on plotter models without Menu Mode. On plotter models with Menu Mode, the default character set is Menu-selectable.

Most computers have an ASCII-coded keyboard. If a character set other than ASCII (G0) is specified, the plotter will print the character set's equivalent symbol (see Table 2-5). For example, if the Mathematics character set (G1) is active and the vertical bar (|) symbol ($7C_{16}$) (125_{10}) on the ASCII-coded keyboard is pressed, then the plotter will draw a pi (π) symbol instead of the ASCII bar.

TABLE 2-5
CHARACTER SETS

CHARACTER SET CODES	34 22	35 23	36 24	64 40	91 5B	92 5C	93 5D	94 5E	95 5F	96 60	123 7B	124 7C	125 7D	126 decimal 7E hexadecimal	STYLE
S(G0)	"	#	$	@	[	\	]	^	_	`	{	|	}	~	ASCII (default)
S(G1)	∫	∏	√	↑	[	α	]	^	_	β	μ	π	→	←	MATHEMATICS
S(G2)	"	#	$	§	Ä	Ö	Ü	^	_	`	ä	ö	ü	ß	GERMAN
S(G3)	"	£	$	à	°	ç	§	^	_	`	é	ù	è	¨	FRENCH
S(G4)	"	#	¤	É	Ä	Ö	Å	Ü	_	é	ä	ö	å	ü	SWEDISH
S(G5)	«	»	$		Æ	Ø	Å	▫	_		æ	ø	å	–	NORWEGIAN/DANISH
S(G6)	"	£	$	§	¡	Ñ	¿	^	_	`	▫	ñ	ç	~	SPANISH
S(G7)	"	£	$	§	°	ç	é	^	_	ù	à	ò	è	ì	ITALIAN

(X*n*, Y*n*,) determines the slope line on which the text will be drawn. The slope line is an imaginary line extending from the point of the pen's current position to the point X*n*,Y*n*, units from the pen.

NOTE

A capital X or Y must precede the respective coordinate value *n*.

character string is the text to be plotted.

__ is an underscore ($5F_{16}$) and indicates the end of the text string. The underscore ($5F_{16}$) is the indicator default value. A different end of text character can be specified by entering the End of Text command (see Section 2.1.6) at the beginning of a plot session. The current end of text character exits the plotter from Extended Text mode.

NOTE

If you need to use either the caret symbol ($5E_{16}$) (94_{10}) or the underscore symbol ($5F_{16}$) (95_{10}) in your text, you must re-define the prompt enable (default caret) and the end of text (default underscore) indicators. Refer to Sections 2.1.5 and 2.1.6. Define the end of text or prompt enable as characters that will not be printed. For example, the Prompt Enable command EB03 defines the prompt enable character as "ETX," and the End of Text command ET04 defines the end of text character as "EOT."

The Extended Text command is an enhancement of the Simple Text (S) command. When S is followed by one or more of the above parameters enclosed in parentheses, the plotter operates in Extended Text mode. This mode should be used when the Simple Text command capabilities can not satisfy your text requirements.

Selecting Character Height and Width:

The current addressing resolution determines the size of the 255 increments (1-255) for the parameters (S*n*) and (W*n*). The (S*n*) command sets the height to *n* times seven times the resolution ($n \times 7 \times$ resolution) and sets the width to *n* times six times the resolution ($n \times 6 \times$ resolution). The (W*n*) command changes only the width to *n* times six times resolution ($n \times 6 \times$ resolution). If the plotter has its resolution set for 0.001 inch, then each character size specifier (1-255) equals an increment of 0.007 inch to the height of the character string. Example: (S1) height = 0.007 inch, (S2) height = 0.014 inch, (S3) height = 0.021 inch, etc.

If the plotter has its resolution set at 0.005 inch, the increments equal 0.035 inch. Example: (S1) height = 0.035 inch, (S2) height = 0.070 inch, (S3) height = 0.105 inch, etc.

If the plotter has its resolution set at 0.1 mm, the increments equal 0.7 mm. Example: (S1) height = 0.7 mm, (S2) height = 1.4 mm, (S3) height = 2.1 mm, etc. A resolution setting at 0.025 mm produces an increment equal to 0.175 mm. Example: (S1) height = 0.175 mm, (S2) height = 0.35 mm, (S3) height = 0.525 mm, etc.

The width after the (S*n*) command is 6/7 the height.

Determining the Slope (X*n*, Y*n*,):

The X*n*, and Y*n*, command parameters enable you to rotate the text at any angle within the plotter's resolution. When X*n*,Y*n*, is specified, the plotter draws the text from the current position of the pen along a line extending through the point specified by X*n*, Y*n*, user units from the current pen position (see Figures 2-3 and 2-4). (The point specified by X*n*, Y*n*, is relative to the current pen position.) If zero is used for either X*n*, or Y*n*, then a 90° rotation occurs. The angle of this rotation depends on the actual numbers given. For example, the command, S (X0,Y100,) TEST__, instructs the pen to draw the word "TEST" upwards with the bottom of the letters to the right (see Figure 2-5).* The command, S (X-100,Y0,) TEST__, instructs the pen to draw the word "TEST" upside-down from the right to the left (see Figure 2-6).*

NOTE

The coordinate value *n* must be preceded by a capital X or Y respectively.

Command Default:

The extended text command default at power up or after reset is: S(S8,NI,G0,X1,Y0,). (Parameter G default can be changed on plotters with Menu-Mode.) These extended text parameters are: character size eight (S8,); no italics (NI); character set zero (G0,) or Menu-selected; X slope coordinate value of one (X1,); and Y slope coordinate value of zero (Y0,). The default values remain in effect until one or more of the parameters are changed, at which time, the S() command may then be used to recall the present extended text parameter values.

* When zero is specified for either X*n*, or Y*n*, any number within the plotter's range and with the proper sign can be used for the remaining value with identical results. This is because (X0,Y1000,) specifies the same line as (X0,Y,), or (X-32767,Y0,) specifies the same line as (X-10,Y0,), and so on.

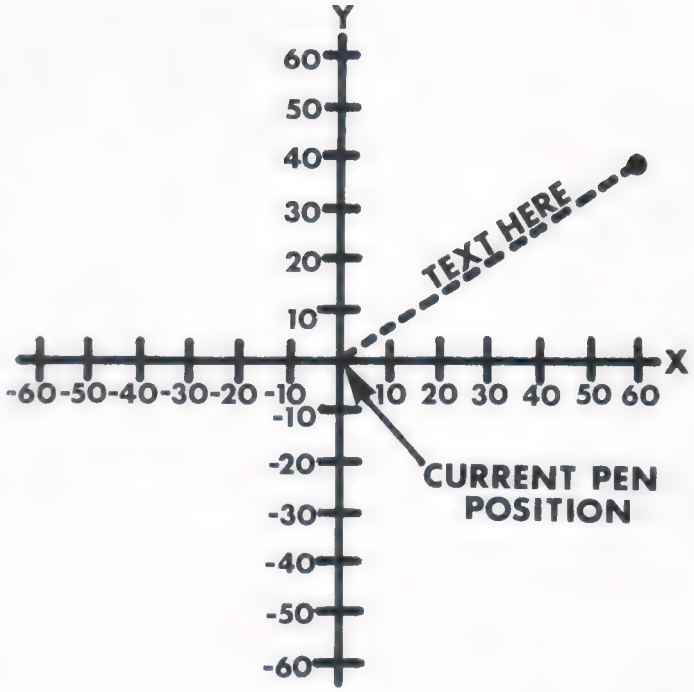


FIGURE 2-3
S(X60,Y40,) SLOPE

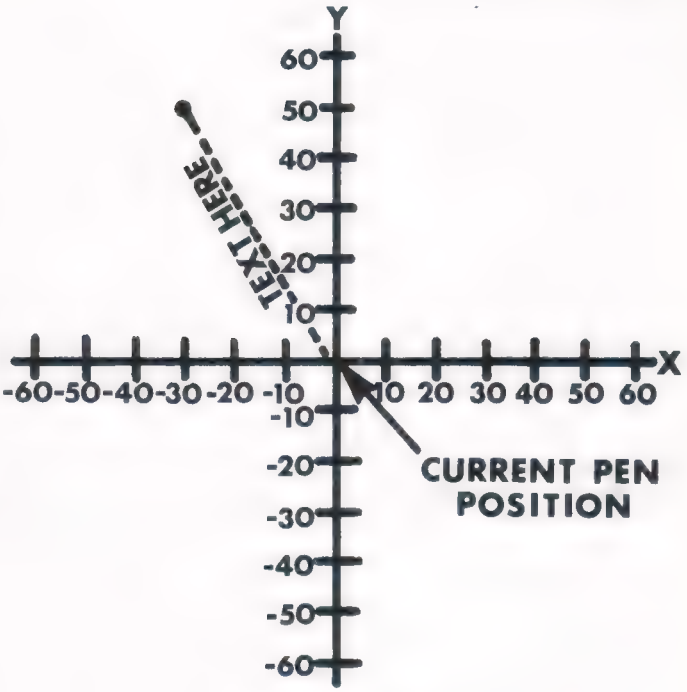


FIGURE 2-4
S(X-30,Y50,) SLOPE

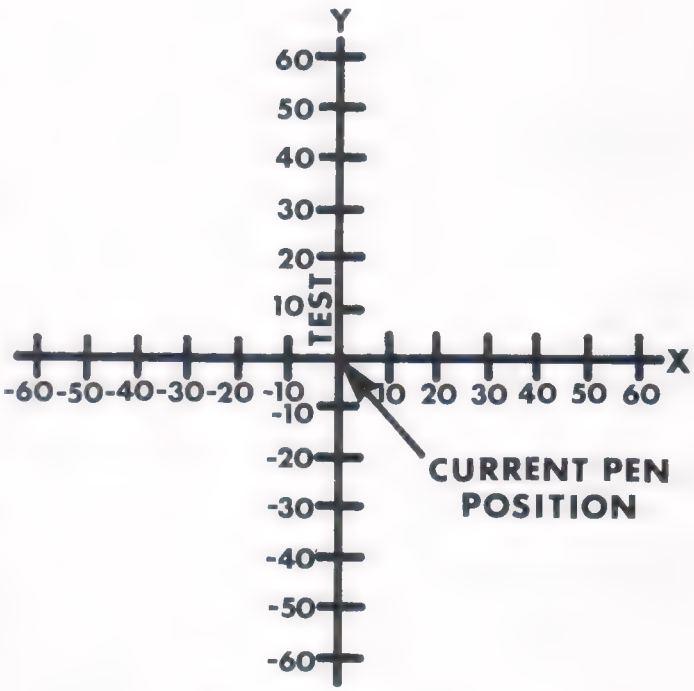


FIGURE 2-5
S(X0,Y100,) SLOPE

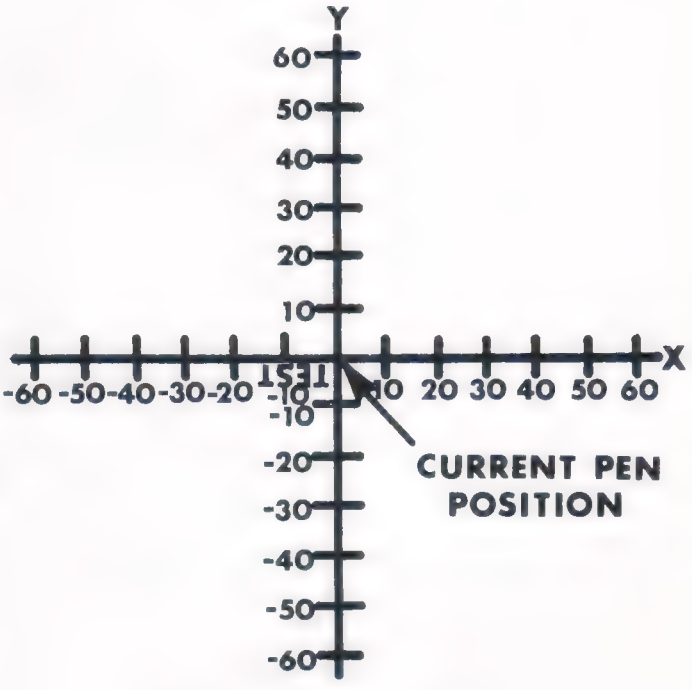


FIGURE 2-6
S(X-100,Y0,) SLOPE

2.7 CURVE COMMANDS

The DM/PL Curve Commands are:

- Circle Plot (CC)
- Arc Plot (CA)
- Ellipse Plot (CE)
- General Curve Plot (CG)

2.7.1 Circle Plot

CC *x,y,r,*

x,y, specifies the center point of the circle. *x* and *y* represent absolute or relative coordinates depending on the most recent A or R command. The center of the circle can be off the plotting surface.

r specifies the radius of the circle and is expressed in user units.

CC, followed by *x,y* and *r*, draws a circle. When this command is issued, the pen moves from its current position to the circumference of a circle that is specified by *x,y,r*. At that point, the pen lowers to the paper and draws the circle in a counterclockwise direction. When it completes the 360° cycle, the pen stops in the pen up position and waits there for the next command. A relative vector following the Circle Plot (CC) command is relative to the center point of the circle.

Example: ;:H A EC5,CC 500,500,200,

In this example, the plotter is selected (;:). Home position is specified (H). Absolute pen positioning is specified (A). The coordinate user addressability is set to .005″ (EC5). Circle Plot is specified, and the pen draws a circle having a radius of one inch around the circle's center point coordinate 500,500, (CC) (see Figure 2-7). The radius was derived from the plotter's user addressability times the radius specifier (.005″ × 200 = 1 inch).

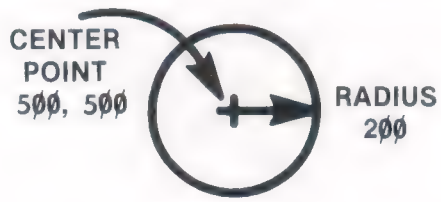


FIGURE 2-7
CIRCLE PLOT

2.7.2 Arc Plot

CA *x,y,d,*

x,y, specifies the center of the circle which contains the arc to be plotted.

d, specifies the size of the arc in degrees and is a numeric expression between −360 and +360.

CA, followed by *x,y,* coordinate and degree (*d,*) specifications, generates an arc. It is important to make note that the arc is begun at the current pen position. The *x,y,* value in the command represents an imaginary center point in a circle if the arc were allowed to travel the complete 360° cycle. (It is, in fact, possible to draw complete circles by specifying either +360 or −360 as the value of *d.*)

The plotter draws the arc in a counterclockwise direction when the sign of the angle is positive (+) and clockwise when the sign is negative (−). The resolution of the arc is ± 1°.

The plotter always draws an arc with the pen down and then restores the pen to the pen state that was current prior to the arc command. A Pen Down (D) command at the end of an arc causes the pen to move to the starting point of the arc and then drop to pen down position. A relative vector following an Arc Plot (CA) command is relative to the arc starting point.

Example: ;:H A 200,300,CA 400,0,45,H

In this example, the plotter is selected (;:). The pen moves to home position (H). Absolute pen positioning is specified (A). The pen moves to absolute coordinate 200,300 (A). The pen draws a 45° arc in a counterclockwise direction (CA). The angle of the arc is relative to the pen position and center point specifiers in the CA command (see Figure 2-8). The pen raises and moves to home position (H).

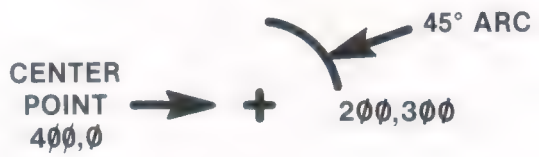


FIGURE 2-8
ARC PLOT

2.7.3 Ellipse Plot

CE *x,y,x1,y1,x2,y2,*

x,y, specifies the center of the ellipse. *x* and *y* may be absolute or relative coordinates depending on the current A or R command.

x1,y1, specifies the length of the lateral axis from the center point (*x,y,*) to the circumference of the ellipse.

x2,y2, specifies the height of the vertical axis from the center point (*x,y,*) to the circumference of the ellipse.

NOTE

x1,y1, and *x2,y2,* are always relative to the center point coordinate *x,y,*. Only the center point coordinate *x,y,* is affected by the current pen positioning mode (A) (R).

CE, followed by the center point and axes information, draws an ellipse centered at *x,y,* with axes specified by *x1,y1,* and *x2,y2,* relative to the center point (*x,y,*) coordinate.

After the pen completes the ellipse, it stops in the pen up position. Any relative vector following the Ellipse Plot (CE) command is relative to the center point coordinates (*x,y,*) of the ellipse.

Example: ;:H A CE 300,200,200,0,0,100,

In this example, the plotter is selected (;:). The pen moves to home position (H). Absolute pen positioning is specified (A). The pen draws an ellipse having a centerpoint of 300,200, (see Figure 2-9) (CE).

FIGURE 2-9
ELLIPSE PLOT

2.7.4 General Curve Plot

(current pen position) CG *x1,y1,x2,y2,... xn,yn,* CS

(current pen position) must be considered when you are using the CG command. The current pen position affects the angle of the line at the first coordinate plot point (*x1,y1,*). The line begins at the first coordinate plot point; however, the tangential angle in the curve of the line begins at the current pen position (see Figures 2-10 and 2-11).

x1,y1,x2,y2,... are the coordinate points for the pen to connect with a smooth, curved line. A space or comma must be placed between each *x,y* coordinate set.

xn,yn, is an imaginary coordinate point used by the plotter to determine the slope of the line at the last actual plot point (*x,y,*). (The pen does not include coordinate *xn,yn,* in the plot.) *xn,yn,* must be the last coordinate set in the command string.

CS exits the plotter from General Curve mode.

The CG command instructs the plotter to connect a series of coordinate points with a smooth, curved line. The coordinate plot points can be either relative or absolute depending on the last (A) or (R) command issued. The type of curved line on the plot depends on the last Line Type (L) command entered.

The General Curve command was designed for your convenience. Since the command is capable of producing a curved line, the only coordinate sets required in the CG command string are the "high" and the "low" coordinate graph points. You may enter any number of coordinate points in the command string.

NOTE

The type of algorithm used for the General Curve function is a non-polynomial parametric interpolation. In general, for every set of four consecutive points (points 1, 2, 3, 4), the algorithm specifies a curve between the middle two points (points 2 and 3). The curve passes through these two points. The slope at point 2 is parallel to a line between points 1 and 3, and the slope at point 3 is parallel to a line between points 2 and 4. The implementation and the code for this function are considered proprietary information of Houston Instrument. However, you can refer to the following references which were used to derive this code.

Conte, S.D. and deBoor, C., *Elementary Numerical Analysis,* McGraw Hill, New York, 1965.

Birkhoff, G. and deBoor, C., "Piecewise Polynomial Interpolation and Approximation," located in *Approximation of Function,* Garabedian, ed., Elseuier Publishing Co., Amsterdam, New York, pgs. 164-190, 1965.

Foley, J. and Van Dam, A., *Fundamentals of Interactive Computer Graphics,* Addison Wesley Publishing Co., Reading, Massachusetts, 1982.

Example:

;:H A CG 200,200,300,900,600,300,900,1100,1100,200,1200,600,CS

In this example, the plotter is selected (;:). The pen moves to home position (H). Absolute pen positioning is specified (A). General curve is specified (CG). The pen moves from its present position (home) to coordinate 200,200, and then lowers to the plotting surface and draws a curved line to coordinate 300,900 (CG). The pen continues to draw the curved line to coordinate 600,300 to 900,1100, and finally to the last coordinate plot point in the command string—1100,200. The pen stops at coordinate 1100,200 and raises from the plotting surface (CG). The plotter used the last coordinate set in the command string (1200,600) to determine the tangential slope of the line at the last coordinate plot point (1100,200) (CG). The plotter exits from general curve mode (CS).

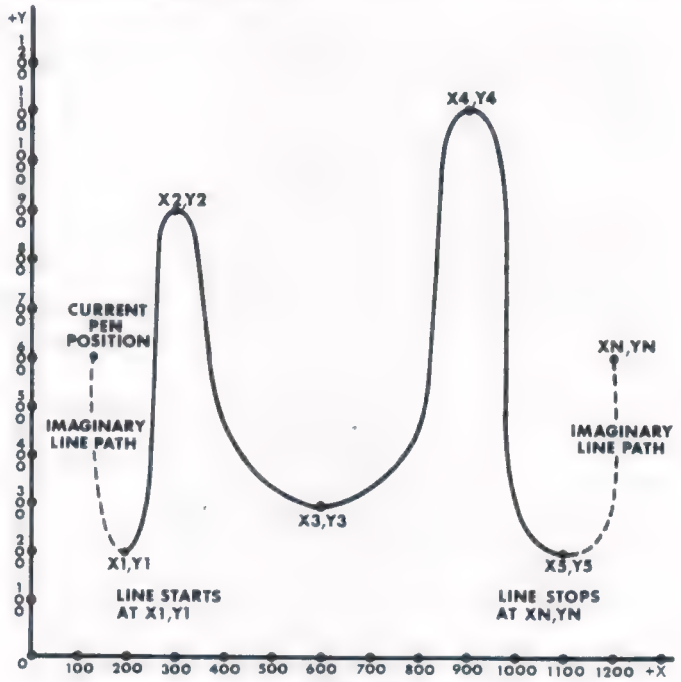


FIGURE 2-10
GENERAL CURVE (CG) COMMAND

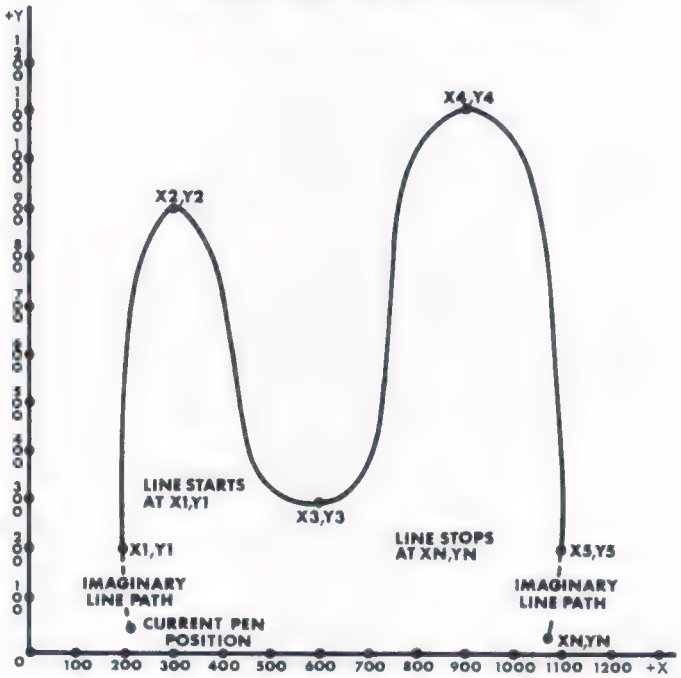


FIGURE 2-11
GENERAL CURVE (CG) COMMAND

Compare the plot in Figure 2-10 with the plot in Figure 2-11. Notice how a different Pen position changed the angle of the line at x1,y1. The slope of the line between x4,y4 and x5,y5 was changed by using a different coordinate value for xn,yn.

2.8 MARKER COMMANDS

The DM/PL Marker Commands are:

- Marker Plot (M)
- Extended Marker Plot (M(S))

2.8.1 Marker Plot

M*hhm*

hh specifies the height of the marker and is expressed as 1, 1+, 2, 2+, 3, 3+, 4, 4+, or 5. It is important to note that *hh* must not be followed by a space.

m specifies the marker type, and is a numeric expression between zero and five.

The Marker Plot (M) command causes the plotter to draw a marker symbol centered at the current position of a specified size. The six marker symbols (see Table 2-6) can be produced in the sizes listed in Tables 2-7a and 2-7b according to the user addressability presently in effect. After a marker is drawn, the plotter returns the pen to its pen status prior to the M command.

TABLE 2-6
MARKER PLOT

CODE	MARKER
0	+
1	x
2	□
3	○
4	△
5	⧖

TABLE 2-7a
ENGLISH UNIT MARKER SIZES

CODE	MARKER SIZE (AT .005 INCH)	MARKER SIZE (AT .001 INCH)
1	0.04 inch	0.008 inch
1+	0.06 inch	0.012 inch
2	0.08 inch	0.016 inch
2+	0.12 inch	0.024 inch
3	0.16 inch	0.032 inch
3+	0.24 inch	0.048 inch
4	0.32 inch	0.064 inch
4+	0.48 inch	0.096 inch
5	0.64 inch	0.128 inch

TABLE 2-7b
METRIC UNIT MARKER SIZES

CODE	MARKER SIZE (AT .1 MM)	MARKER SIZE (AT .025 MM)
1	0.8 mm	0.2 mm
1+	1.2 mm	0.3 mm
2	1.6 mm	0.4 mm
2+	2.4 mm	0.6 mm
3	3.2 mm	0.8 mm
3+	4.8 mm	1.2 mm
4	6.4 mm	1.6 mm
4+	9.6 mm	2.4 mm
5	12.8 mm	3.2 mm

Example: ;:H A 200,350 M32

In this example, the plotter moves to home position (H). Absolute pen positioning is specified (A). The pen is moved to absolute coordinate 200,350. The pen draws the specified marker symbol at the specified height, and then restores its previous pen status (M).

NOTE

The plotter requires a new M command format for each marker in a string.

2.8.2 Extended Marker Plot

M(S*n*)*m*

(S*n*) specifies the height of the marker and is a numeric expression between one and 255.

m specifies the marker symbol, and is a numeric expression between zero and five (see Table 2-6).

The Extended Marker Plot command enables you to plot the six centered marker symbols listed in Table 2-6 in a greater variety of sizes. This command can be used instead of the Marker Plot (M) command where marker size is critical. When a number between one and 255 is specified for *n*, the size of the marker will be eight times that number times the current user addressability (.001″, .005″, .1 mm, or .025 mm). For example, the command M(S40)4 produces a triangle marker .320″ in height on a plotter having .001″ addressability (40 × 8 × .001″).

After a size is specified, all other marker symbols produced by either marker command will be drawn at that size if the size parameter is omitted from the command format. If the size is changed by another marker size parameter, then that size becomes current.

2.9 INQUIRY COMMANDS

The DM/PL Inquiry Commands are:

- Report (ER)
- Query (Q)
- Digitize (ED)

2.9.1 Report

ER

The Report (ER) command enables the plotter to send its current status to the computer. When the plotter processes a Report (ER) command, the following information is transmitted to the computer:

- The number of the last selected pen.
- The current status of the pen (up or down).
- Whether or not the present location of the pen on the plotting surface is inside the current window limits.
- The current chart format (large or small).
- The present position (x,y) of the pen.
- The present window limit coordinates.
- The present viewport limit coordinates.

NOTE

All coordinates are in user units and relative to the fixed origin of the current chart size.

The (ASCII BCD) format of the report from the plotter to the computer consists of two, three-digit status bytes, followed by ten, six-digit coordinates and one terminator <CR> — a total of 90 characters. Your computer software guide should provide instructions for programming the computer to receive the report data in Figure 2-12.

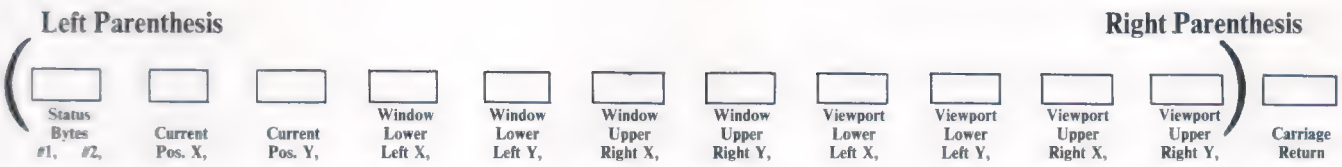
Example of Report (ER) data from plotter:

(033,000, 01000, 00010, 00200, 01100, 00400, 01600, 00550, 00100, 00800, 01000) <CR>

NOTE

The plotter signs positive coordinate values with a space and negative coordinates with a minus (−). Some plotter models have higher plotting ranges than other models and will transmit six-digit coordinates in Report (see your operator's manual).

The status of the plotter in this example report statement is: Status Byte One (033 = 00100001) shows that pen number 0001 was the last requested pen and it is presently in the up position outside the present window limits, and the plotter is in large chart format. Status Byte Two is (000) is reserved (but not used). The x coordinate of the pen's present position is 01000. The y coordinate of the pen's present position is 00010. The window's lower left x coordinate is 00200. The window's lower left y coordinate is 01100. The window's upper right x coordinate is 00400. The window's upper right y coordinate is 01600. The viewport's lower left x coordinate is 00550. The viewport's lower left y coordinate is 00100. The viewport's upper right x coordinate is 00800. The viewport's upper right y coordinate is 01000. Carriage return <CR>.



STATUS BYTE ONE

(MSB) POS. 7	POS 6	POS. 5	POS. 4	POS. 3	POS. 2	POS. 1	POS. Ø (LSB)
Ø	Ø = LARGE CHART 1 = SMALL CHART	Ø = INSIDE WINDOW 1 = OUTSIDE WINDOW	Ø = PEN UP 1 = PEN DN	← CURRENT PEN NUMBER →			
128	64	32	16	8	4	2	1

ØØ11 = PEN 3
Ø1ØØ = PEN 4
ØØØ1 = PEN 1
ØØ1Ø = PEN 2

STATUS BYTE TWO

(MSB) POS. 7	POS. 6	POS. 5	POS. 4	POS. 3	POS. 2	POS. 1	POS. Ø (LSB)
R	E	S	E	R	V	E	D
Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø

FIGURE 2-12
REPORT FORMAT

2.9.2 Query

Q

The Query (Q) command is used to report plotter identification information to the host computer. When this command is processed, the plotter immediately sends its model number and its ROM(s) (Read Only Memory) identification number(s) (the first four digits indicate the ROM part number, while the last three digits indicate the ROM revision level) to the host. An example of the Q information is shown below.

(DMP51 0375001) <CR>

2.9.3 Digitize

ED

The Digitize (ED) command places the plotter in digitizer mode. When the plotter processes this command and enters digitizer mode, it switches to LOCAL (the LOCAL LED indicator on the control panel illuminates), and stops plotting. After it switches to LOCAL, you can use the plotter's manual movement buttons to move the pen over the point to be digitized. The plotter transmits that point's position to the computer when the REMOTE button is pressed. An ED command is required for each point to be digitized. Your operator's manual contains instructions on how to manually operate your plotter and what format your plotter uses to transmit the coordinate data.

2.10 PLOTTER CONTROL COMMANDS

The DM/PL Plotter Control Commands are:

- Plotter Test (T)
- Plotter Reset (Z)
- Pass-Through Port Enable (X)
- Plot Pause (EL)
- Keyboard Mask (EM)
- UART Setup (EU)

2.10.1 Plotter Test

T

The Plotter Test (T) command selects the Self-Test routine, which tests the plotter's logic and then draws the Self-Test plot. All previous specified plot commands are lost when Plotter Test (T) is issued. After the Plotter Test has completed, the plotter must be selected to continue plotting activity. This Self-Test routine is identical to the test that can be initiated locally at the plotter's control panel.

The plot produced by this routine contains plotter model and ROM revision information and various alphanumeric and symbol characters. Your operator's manual describes Self-Test in detail.

2.10.2 Plotter Reset

Z

The Plotter Reset (Z) resets the plotter. This command is processed in the order received. All data before this command will be processed, while all data after it will be cleared from the buffer. A Select command (;: or ;:I) must be issued before the plotter can resume remote operation after a Reset (Z) command.

NOTE

From a programming standpoint, it is better to use the DM/PL Deselect (@) command (rather than the Z command) to terminate plotting operations. This is because any plot codes you send to the plotter after a Z command will be "dumped" after the Z command is processed. If the plotter's buffer is full, the plotter will not process a Z command immediately.

2.10.3 Pass-Through Port Enable

X

The X command turns on the pass-through port function on plotter models with pass-through port capabilities. The pass-through port function is explained in your operator's manual.

2.10.4 Plot Pause

EL

The Plot Pause (EL) command enables you to suspend the processing of a program at any point for whatever reason, and then resume its processing without losing data.

After the plotter receives an EL command, it stops plotting and switches to local mode. The plotter resumes its plotting activities when it manually returned to remote mode.

2.10.5 Keyboard Mask

EM

The Keyboard Mask (EM) command is used to disable certain front panel control functions on the plotter. This command is plotter specific and is explained in your operator's manual.

2.10.6 UART Setup

EU*nnn*,

nnn is a three-digit command code which specifies the type of format for the data transmitted from the plotter (the UART circuit in the plotter) to the computer.

The UART Setup command enables you to use your software to select the type of format and parity of the data that is transmitted from the plotter to your computer. After an EU command is entered, the format remains current until another EU command is issued, or until the plotter is powered down. The EU command default value is code 200.

To be effective, the EU command must be issued immediately after the plotter initialization command (Mode One or Mode Two Select).

The numeric codes for *nnn* and the respective data formats are listed below.

If the numeric code for *nnn* is:

200 then the data format is seven data bits, no parity with bit number eight set to zero (0), and two stop bits.* (EU200 is the command default value.)

201 then the data format is seven data bits, no parity with bit number eight set to one (1), and two stop bits.*

206 then the data format is seven data bits, with bit number eight set for odd parity, and two stop bits.*

222 then the data format is seven data bits, with bit number eight set for even parity, and two stop bits.*

The EU command is plotter specific, therefore, refer to your operator's manual for more detail.

2.11 DM/PL PROGRAMMING CONSIDERATIONS

- A value (integer) which is not signed will be a positive value. A negative x or y value must always be specified with a minus sign (−15, −293, etc.).

*The two stop bits refer only to characters sent by the plotter. Characters transmitted from the computer to the plotter can have either one or two stop bits.

- A Mode Two software handshake occurs before the transmission of a data block of 256 bytes or less. You should program your computer to transmit in block sizes of 256 bytes or less, separated by the ASCII character you define in the select sequence with a two-digit hexadecimal number (prompt). The plotter responds with its response code(s) if it can receive up to 256 bytes.

- Most DM/PL compatible plotter models have front control panels. These control panels have buttons that specify which source of control the plotter will respond to (local mode for manual control or remote mode for computer control). The plotter will not respond to your computer (Mode One or Mode Two Select commands or plot data) if remote mode is not specified on the control panel. (Your operator's manual provides instructions on how to configure the control panel for remote control.)

- A Deselect (@) command takes the plotter off-line and reserves the current software settings (window limits, resolution, etc.) for the next Select command. A Reset (Z) command takes the plotter off-line and resets all current software settings to their default values. (The default values for your plotter are listed in its operator's manual.)

- When writing programs for your plotter, you must consider the plotter's current addressability. For example, let's say you are working in English units and want to draw a line four inches long. This is easily accomplished by first calculating how many increments are in an inch, and then multiplying by four. If you have specified an addressability of .005″, the formula for the example above is:

  .005″ × 200 increments = 1.0″

  200 increments × 4 = 800 increments (4.0″)

  or with a .001″ addressability:

  .001″ × 1000 increments = 1.0″

  1000 increments × 4 = 4000 increments (4.0″)

  If you are working in metric units and want to draw a line four centimeters long, the formula for a plotter having a specified addressability of .1 mm is:

  .1 mm × 100 increments = 1 cm

  100 increments × 4 = 400 increments (4 cm)

  or with a .025 mm addressability:

  .025 mm × 400 increments = 1 cm

  400 increments × 4 = 1600 increments (4 cm)

- When writing plotter programs of more than one line, include one delimiter (comma or space) between the last item on the line and the carriage return. Otherwise, any following program lines will be lost.

  Example: ;:H A CC 800,800,100,<CR>

  CC 800,800,200,<CR>

  CC 800,800,300,Z

  Note that there is a comma between the last item and carriage return on lines one and two, since there is subsequent program data.

SECTION 3
DM/PL COMMAND FORMAT SUMMARY

3.1 INTRODUCTION

This section is a summary of the DM/PL command formats that are explained in Section 2. The summary is included for your convenience. After you become familiar with the DM/PL command structure, you can use this section as a quick reference to a command's format.

DESCRIPTION	COMMAND	REFERENCE PARAGRAPH
PLOTTER SELECT COMMANDS		
Mode One Select	;:	1.2.1
Mode Two Select pc = computer prompt code d = time delay, 0 to 255 (xx) = optional plotter response codes	;:I pc d, or ;:I(xx,xx,xx,xx) pc d,	1.2.2
Deselect	@	1.2.3
PLOT SETUP COMMANDS		
Small Chart	EH	2.1.1
Large Chart	EF	2.1.2
Set Velocity n = velocity in ips or cps (0-255)	Vn,	2.1.3
Set Window/Viewport Limits wxll,wyll = window lower left limit coordinates wxur,wyur = window upper right limit coordinates vpxll,vpyll = viewport lower left limit coordinates vpxur,vpyur = viewport upper right limit coordinates	W wxll,wyll, wxur,wyur, vpxll,vpyll, vpxur,vpyur,	2.1.4
Mode Two Prompt Enable nn = 00 to 7F (hex) default is 5E (caret)	EBnn,	2.1.5
End of Text nn = 00 to 7F (hex) default is 5F (underscore)	ETnn,	2.1.6
Frame Advance	Fn,	2.1.7
ADDRESSING COMMANDS		
Absolute Pen Positioning	A	2.2.1
Relative Pen Positioning	R	2.2.2
Coordinate Addressing n = 1 for .001″ 5 for .005″ M for .1 mm N for .025 mm	ECn,	2.2.3
Home Position	H	2.2.4
Set Plot Origin	O	2.2.5

DM/PL COMMAND FORMAT SUMMARY

DESCRIPTION	COMMAND	REFERENCE PARAGRAPH
PEN CONTROL COMMANDS		
New Pen n = any pen number	Pn,	2.3.1
Pen Down	D	2.3.2
Pen Up	U	2.3.3
LINE CONTROL COMMANDS		
Line Type n = :, or 0 through 9 (0 is default value)	Ln,	2.4.1
MOVE COMMANDS		
Vector Move To Specified Coordinate nx = next x coordinate ny = next y coordinate	nx,ny,	2.5.1
Incremental Moves		2.5.2
+y	p	
+x,+y	q	
+x	r	
+x,−y	s	
−y	t	
−x,−y	u	
−x	v	
−x,+y	w	
Pen up	y	
Pen down	z	
TEXT COMMANDS		
Simple Text 1 = 0° rotation 2 = 90° rotation 3 = 180° rotation 4 = 270° rotation hh = height value CHAR = character string __ = end of text default character	Srhh CHAR __	2.6.1
Extended Text S = parameter set within () is plotted Sn = character height and width, 0 to 255 Wn = character width only, 0 to 255 I = italic character NI = non-italic (block) character Gn = character set n = 0 for ASCII n = 1 for mathematics n = 2 for German n = 3 for French n = 4 for Swedish n = 5 for Danish/Norwegian n = 6 for Spanish n = 7 for Italian Xn,Yn = line slope point coordinates CHAR = character string __ = end of text default character	S(Sn,Wn, I/NI,Gn, Xn,Yn) CHAR __	2.6.2

DESCRIPTION	COMMAND	REFERENCE PARAGRAPH
CURVE COMMANDS		
Circle Plot x = center point x coordinate y = center point y coordinate r = radius	CC x,y,r,	2.7.1
Arc Plot x = center point x coordinate y = center point y coordinate d = arc degrees	CA x,y,d,	2.7.2
Ellipse Plot x = center point x coordinate y = center point y coordinate x1 = lateral axis x coordinate y1 = lateral axis y coordinate x2 = vertical axis x coordinate y2 = vertical axis y coordinate	CE x,y, x1,y1, x2,y2,	2.7.3
General Curve Plot x1,y1,x2,y2 ... = coordinate pairs along the desired curve xn,yn = imaginary curve end point coordinate pair CS = exit from General Curve Plot	CG x1,y1, x2,y2 ... xn,yn, CS	2.7.4
MARKER COMMANDS		
Marker Plot hh = height specifier (1, 1+, 2, 2+, 3, 3+, 4, 4+, 5) m = marker symbol 0 = plus symbol 1 = x symbol 2 = box symbol 3 = octagon symbol 4 = triangle symbol 5 = double triangle symbol	Mhhm	2.8.1
Extended Marker Plot (Sn) = marker size in user increments (0 to 255) m = marker symbol (0 to 5)	M(Sn)m	2.8.2
INQUIRY COMMANDS		
Report	ER	2.9.1
Query	Q	2.9.2
Digitize	ED	2.9.3

DM/PL COMMAND FORMAT SUMMARY

DESCRIPTION	COMMAND	REFERENCE PARAGRAPH
PLOTTER CONTROL COMMANDS		
Plotter Test	T	2.10.1
Plotter Reset	Z	2.10.2
Pass-Through Port Enable	X	2.10.3
Plot Pause	EL	2.10.4
Keyboard Mask	EM	2.10.5
UART Setup nnn = setup code (200, 201, 206, 222) 200 = 7 data bits, no parity, bit 8 = 0, 2 stop bits (default) 201 = 7 data bits, no parity, bit 8 = 1, 2 stop bits. 206 = 7 data bits, bit 8 = odd parity, 2 stop bits. 222 = 7 data bits, bit 8 = even parity, 2 stop bits.	EUnnn,	2.10.6

APPENDIX A
CHARACTER SETS

TABLE A-1
ASCII CHARACTER SET

DEC	HEX	OCT	CHAR	DEC	HEX	OCT	CHAR	DEC	HEX	OCT	CHAR
00	00	00	NUL (note 1)	43	2B	53	+	85	55	125	U
01	01	01	SOH (note 1)	44	2C	54	,	86	56	126	V
02	02	02	STX (note 1)	45	2D	55	–	87	57	127	W
03	03	03	ETX (note 1)	46	2E	56	.	88	58	130	X
04	04	04	EOT (note 1)	47	2F	57	/	89	59	131	Y
05	05	05	ENQ (note 1)	48	30	60	0	90	5A	132	Z
06	06	06	ACK (note 1)	49	31	61	1	91	5B	133	[
07	07	07	BEL (note 1)	50	32	62	2	92	5C	134	\
08	08	10	BS	51	33	63	3	93	5D	135	]
09	09	11	HT (note 1)	52	34	64	4	94	5E	136	(caret)
10	0A	12	LF	53	35	65	5	95	5F	137	—
11	0B	13	VT (note 1)	54	36	66	6	96	60	140	‘
12	0C	14	FF (note 1)	55	37	67	7	97	61	141	a
13	0D	15	CR	56	38	70	8	98	62	142	b
14	0E	16	SO (note 1)	57	39	71	9	99	63	143	c
15	0F	17	SI (note 1)	58	3A	72	:	100	64	144	d
16	10	20	DLE (note 1)	59	3B	73	;	101	65	145	e
17	11	21	DC1	60	3C	74	<	102	66	146	f
18	12	22	DC2	61	3D	75	=	103	67	147	g
19	13	23	DC3 (note 1)	62	3E	76	>	104	68	150	h
20	14	24	DC4 (note 1)	63	3F	77	?	105	69	151	i
21	15	25	NAK (note 1)	64	40	100	@	106	6A	152	j
22	16	26	SYN (note 1)	65	41	101	A	107	6B	153	k
23	17	27	ETB (note 1)	66	42	102	B	108	6C	154	l
24	18	30	CAN (note 1)	67	43	103	C	109	6D	155	m
25	19	31	EM (note 1)	68	44	104	D	110	6E	156	n
26	1A	32	SUB (note 1)	69	45	105	E	111	6F	157	o
27	1B	33	ESC (note 1)	70	46	106	F	112	70	160	p
28	1C	34	FS (note 1)	71	47	107	G	113	71	161	q
29	1D	35	GS (note 1)	72	48	110	H	114	72	162	r
30	1E	36	RS (note 1)	73	49	111	I	115	73	163	s
31	1F	37	US (note 1)	74	4A	112	J	116	74	164	t
32	20	40	(blank)	75	4B	113	K	117	75	165	u
33	21	41	!	76	4C	114	L	118	76	166	v
34	22	42	”	77	4D	115	M	119	77	167	w
35	23	43	#	78	4E	116	N	120	78	170	x
36	24	44	$	79	4F	117	O	121	79	171	y
37	25	45	%	80	50	120	P	122	7A	172	z
38	26	46	&	81	51	121	Q	123	7B	173	{
39	27	47	’	82	52	122	R	124	7C	174	|
40	28	50	(	83	53	123	S	125	7D	175	}
41	29	51	)	84	54	124	T	126	7E	176	~
42	2A	52	*					127	7F	177	DEL (note 1)

NOTE 1: This character is not normally used by the plotter. It is treated as a “no operation” command.

TABLE A-2
CHARACTER SET DIFFERENCES

CHARACTER SET CODES	34 22	35 23	36 24	64 40	91 5B	92 5C	93 5D	94 5E	95 5F	96 60	123 7B	124 7C	125 7D	126 decimal 7E hexadecimal	STYLE
S(GØ)	"	#	$	@	[	\	]	^	_	`	{	|	}	~	ASCII (default)
S(G1)	∫	∏	√	↑	[	α	]	^	_	β	μ	π	→	←	MATHEMATICS
S(G2)	"	#	$	§	Ä	Ö	Ü	^	_	`	ä	ö	ü	ß	GERMAN
S(G3)	"	£	$	à	°	ç	§	^	_	`	é	ù	è	¨	FRENCH
S(G4)	"	#	¤	É	Ä	Ö	Å	Ü	_	é	ä	ö	å	ü	SWEDISH
S(G5)	«	»	$		Æ	Ø	Å	▫	_		æ	ø	å	-	NORWEGIAN/DANISH
S(G6)	"	£	$	§	¡	Ñ	¿	^	_	`	°	ñ	ç	~	SPANISH
S(G7)	"	£	$	§	°	ç	é	^	_	ù	à	ò	è	ì	ITALIAN

APPENDIX B
DM/PL COMPATIBLE PLOTTERS LISTING

The model numbers of the DM/PL compatible plotters manufactured by Houston Instrument (as of this printing) and a summary of the commands they support are listed below.

COMMAND (ASCII)	DESCRIPTION	REF. SECTION
HIPLØT® DMP-3, 4, 6, 7, 8, and 9 Plotters with serial numbers beginning with letter "B":		
A	Absolute Pen Positioning	2.2.1
CA	Arc Plot	2.7.2
CC	Circle Plot	2.7.1
CE	Ellipse Plot	2.7.3
CG	General Curve Plot	2.7.4
CS	General Curve Plot Terminator	2.7.4
D	Pen Down	2.3.2
F	Frame Advance	2.1.7
H	Home Position	2.2.4
L	Line Type	2.4.1
M	Marker Plot	2.8.1
O	Set Plot Origin	2.2.5
P	New Pen	2.3.1
R	Relative Pen Positioning	2.2.2
S	Simple Text	2.6.1
T	Plotter Test	2.10.1
U	Pen Up	2.3.3
Z	Plotter Reset	2.10.2
;:	Mode One Plotter Select	1.2.1
;:I	Mode Two Plotter Select	1.2.2
@	Plotter Deselect	1.2.3
x,y	Vector Move to Specified Coordinate	2.5.1
p	incremental +y	2.5.2
q	incremental +x, +y	2.5.2
r	incremental +x	2.5.2
s	incremental +x, −y	2.5.2
t	incremental −y	2.5.2
u	incremental −x, −y	2.5.2
v	incremental −x	2.5.2
w	incremental −x, +y	2.5.2
y	pen up	2.5.2
z	pen down	2.5.2
HIPLØT DMP-3, 4, 6, 7, 8, and 9 Plotters (all other serial numbers):		
A	Absolute Pen Positioning	2.2.1
D	Pen Down	2.3.2
F	Frame Advance	2.1.7
H	Home Position	2.2.4
L	Line Type	2.4.1
M	Marker Plot	2.8.1
O	Set Plot Origin	2.2.5
P	New Pen	2.3.1
R	Relative Pen Positioning	2.2.2

COMMAND (ASCII)	DESCRIPTION	REF. SECTION
HIPLØT DMP-3, 4, 6, 7, 8, and 9 Plotters (all other serial numbers) (continued):		
S	Simple Text	2.6.1
T	Plotter Test	2.10.1
U	Pen Up	2.3.3
Z	Plotter Reset	2.10.2
;:	Mode One Plotter Select	1.2.1
;:I	Mode Two Plotter Select	1.2.2
@	Plotter Deselect	1.2.3
x,y	Vector Move to Specified Coordinate	2.5.1
HIPLØT DMP-40 Series Plotters (includes models DMP-40, DMP-41, and DMP-42):		
A	Absolute Pen Positioning	2.2.1
CA	Arc Plot	2.7.2
CC	Circle Plot	2.7.1
CE	Ellipse Plot	2.7.3
CG	General Curve Plot	2.7.4
CS	General Curve Plot Terminator	2.7.4
D	Pen Down	2.3.2
EB	(Mode Two) Prompt Enable	2.1.5
EC	Coordinate Addressing	2.2.3
EF	Large Chart	2.1.2
EH	Small Chart	2.1.1
EL	Plot Pause	2.10.4
ER	Report	2.9.1
ET	End of Text	2.1.6
EU	UART Setup	2.10.6
H	Home Position	2.2.4
L	Line Type	2.4.1
M	Marker Plot	2.8.1
O	Set Plot Origin	2.2.5
P	New Pen	2.3.1
Q	Query	2.9.2
R	Relative Pen Positioning	2.2.2
S	Simple Text	2.6.1
S()	Extended Text	2.6.2
T	Plotter Test	2.10.1
U	Pen Up	2.3.3
V	Set Velocity	2.1.3
W	Set Window/Viewport Limits	2.1.4
Z	Plotter Reset	2.10.2
;:	Mode One Plotter Select	1.2.1
;:I	Mode Two Plotter Select	1.2.2
@	Plotter Deselect	1.2.3
x,y	Vector Move to Specified Coordinate	2.5.1
p	incremental +y	2.5.2
q	incremental +x, +y	2.5.2
r	incremental +x	2.5.2
s	incremental +x, −y	2.5.2
t	incremental −y	2.5.2
u	incremental −x, −y	2.5.2
v	incremental −x	2.5.2
w	incremental −x, +y	2.5.2
y	pen up	2.5.2
z	pen down	2.5.2

COMMAND (ASCII)	DESCRIPTION	REF. SECTION
HIPLØT DMP-29 Plotters:		
A	Absolute Pen Positioning	2.2.1
CA	Arc Plot	2.7.2
CC	Circle Plot	2.7.1
CE	Ellipse Plot	2.7.3
CG	General Curve Plot	2.7.4
CS	General Curve Plot Terminator	2.7.4
D	Pen Down	2.3.2
EB	(Mode Two) Prompt Enable	2.1.5
EC	Coordinate Addressing	2.2.3
ED	Digitize	2.9.3
EF	Large Chart	2.1.2
EH	Small Chart	2.1.1
EL	Plot Pause	2.10.4
EM	Keyboard Mask	2.10.5
ER	Report	2.9.1
ET	End of Text	2.1.6
EU	UART Setup	2.10.6
F	Frame Advance	2.1.7
H	Home Position	2.2.4
L	Line Type	2.4.1
M	Marker Plot	2.8.1
O	Set Plot Origin	2.2.5
P	New Pen	2.3.1
Q	Query	2.9.2
R	Relative Pen Positioning	2.2.2
S	Simple Text	2.6.1
S()	Extended Text	2.6.2
T	Plotter Test	2.10.1
U	Pen Up	2.3.3
V	Set Velocity	2.1.3
W	Set Window/Viewport Limits	2.1.4
X	Pass-Through Port Enable	2.10.3
Z	Plotter Reset	2.10.2
;:	Mode One Plotter Select	1.2.1
;:I	Mode Two Plotter Select	1.2.2
@	Plotter Deselect	1.2.3
x,y	Vector Move to Specified Coordinate	2.5.1
p	incremental +y	2.5.2
q	incremental +x, +y	2.5.2
r	incremental +x	2.5.2
s	incremental +x, −y	2.5.2
t	incremental −y	2.5.2
u	incremental −x, −y	2.5.2
v	incremental −x	2.5.2
w	incremental −x, +y	2.5.2
y	pen up	2.5.2
z	pen down	2.5.2
HIPLØT DMP-50 Series Plotters (includes models DMP-51 and DMP-52):		
A	Absolute Pen Positioning	2.2.1
CA	Arc Plot	2.7.2
CC	Circle Plot	2.7.1
CE	Ellipse Plot	2.7.3
CG	General Curve Plot	2.7.4
CS	General Curve Plot Terminator	2.7.4
D	Pen Down	2.3.2
EB	(Mode Two) Prompt Enable	2.1.5

COMMAND (ASCII)	DESCRIPTION	REF. SECTION
EC	Coordinate Addressing	2.2.3
EF	Large Chart	2.1.2
EH	Small Chart	2.1.1
EL	Plot Pause	2.10.4
ER	Report	2.9.1
ET	End of Text	2.1.6
EU	UART Setup	2.10.6
F	Frame Advance	2.1.7
H	Home Position	2.2.4
L	Line Type	2.4.1
M	Marker Plot	2.8.1
M()	Extended Marker Plot	2.8.2
O	Set Plot Origin	2.2.5
P	New Pen	2.3.1
Q	Query	2.9.2
R	Relative Pen Positioning	2.2.2
S	Simple Text	2.6.1
S()	Extended Text	2.6.2
T	Plotter Test	2.10.1
U	Pen Up	2.3.3
V	Set Velocity	2.1.3
W	Set Window/Viewport Limits	2.1.4
X	Pass-Through Port Enable	2.10.3
Z	Plotter Reset	2.10.2
;:	Mode One Plotter Select	1.2.1
;:I	Mode Two Plotter Select	1.2.2
@	Plotter Deselect	1.2.3
x,y	Vector Move to Specified Coordinate	2.5.1
p	incremental +y	2.5.2
q	incremental +x, +y	2.5.2
r	incremental +x	2.5.2
s	incremental +x, −y	2.5.2
t	incremental −y	2.5.2
u	incremental −x, −y	2.5.2
v	incremental −x	2.5.2
w	incremental −x, +y	2.5.2
y	pen up	2.5.2
z	pen down	2.5.2
CØMPLØT® CPS-19 Plotter (DM/PL compatible model only):		
A	Absolute Pen Positioning	2.2.1
CA	Arc Plot	2.7.2
CC	Circle Plot	2.7.1
CE	Ellipse Plot	2.7.3
CG	General Curve Plot	2.7.4
CS	General Curve Plot Terminator	2.7.4
D	Pen Down	2.3.2
EB	(Mode Two) Prompt Enable	2.1.5
EC	Coordinate Addressing	2.2.3
EF	Large Chart	2.1.2
EH	Small Chart	2.1.1
ER	Report	2.9.1
ET	End of Text	2.1.6
EU	UART Setup	2.10.6

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COMMAND (ASCII)	DESCRIPTION	REF. SECTION
CØMPLØT® CPS-19 Plotter (DM/PL compatible model only):		
H	Home Position	2.2.4
L	Line Type	2.4.1
M	Marker Plot	2.8.1
O	Set Plot Origin	2.2.5
P	New Pen	2.3.1
Q	Query	2.9.2
R	Relative Pen Positioning	2.2.2
S	Simple Text	2.6.1
S()	Extended Text	2.6.2
T	Plotter Test	2.10.1
U	Pen Up	2.3.3
V	Set Velocity	2.1.3
W	Set Window/Viewport Limits	2.1.4
Z	Plotter Reset	2.10.2
;:	Mode One Plotter Select	1.2.1
;:I	Mode Two Plotter Select	1.2.2
@	Plotter Deselect	1.2.3
x,y	Vector Move to Specified Coordinate	2.5.1
p	incremental +y	2.5.2
q	incremental +x, +y	2.5.2
r	incremental +x	2.5.2
s	incremental +x, −y	2.5.2
t	incremental −y	2.5.2
u	incremental −x, −y	2.5.2
v	incremental −x	2.5.2
w	incremental −x, +y	2.5.2
y	pen up	2.5.2
z	pen down	2.5.2
PC Series Digital Plotters (includes models 595 and 695):		
A	Absolute Pen Positioning	2.2.1
CA	Arc Plot	2.7.2
CC	Circle Plot	2.7.1
CE	Ellipse Plot	2.7.3
CG	General Curve Plot	2.7.4
CS	General Curve Plot Terminator	2.7.4
D	Pen Down	2.3.2
EB	(Mode Two) Prompt Enable	2.1.5
EC	Coordinate Addressing	2.2.3
ED	Digitize	2.9.3
EF	Large Chart	2.1.2
EH	Small Chart	2.1.1
EL	Plot Pause	2.10.4
ER	Report	2.9.1
ET	End of Text	2.1.6
EU	UART Setup	2.10.6
F	Frame Advance	2.1.7
H	Home Position	2.2.4
L	Line Type	2.4.1
M	Marker Plot	2.8.1
M()	Extended Marker Plot	2.8.2
O	Set Plot Origin	2.2.5

COMMAND (ASCII)	DESCRIPTION	REF. SECTION
PC Series Digital Plotters (includes models 595 and 695):		
P	New Pen	2.3.1
Q	Query	2.9.2
R	Relative Pen Positioning	2.2.2
S	Simple Text	2.6.1
S()	Extended Text	2.6.2
T	Plotter Test	2.10.1
U	Pen Up	2.3.3
V	Set Velocity	2.1.3
W	Set Window/Viewport Limits	2.1.4
Z	Plotter Reset	2.10.2
;:	Mode One Plotter Select	1.2.1
;:I	Mode Two Plotter Select	1.2.2
@	Plotter Deselect	1.2.3
x,y	Vector Move to Specified Coordinate	2.5.1

APPENDIX C
SAMPLE PROGRAMS

C.1 INTRODUCTION

This appendix provides plotting examples for you to use to learn about your plotting system. The plots are generated using the host computer, its BASIC computer language, the DM/PL plotting commands, and the plotter. These simple examples illustrate several concepts necessary for successful plotting. This can help you when writing your own plotting programs. Also, successful completion of any of these tests verifies operation between the host computer and the plotter.

Note that these examples assume that you are familiar with your computer and its BASIC computer language. An explanation of these is beyond the scope of this manual. Refer to the documents supplied with the host computer for these details.

Also, because of the differences in computers and the BASIC languages used in them, it is impossible to give one program listing to illustrate these examples. In many cases the computer setup and language syntax are computer-specific. Therefore in these examples, three popular computer types are used. This is so that the greatest number of users may benefit from the examples. The computer types are:

- IBM PC™. This covers the various models of IBM PC computers. It may also cover many so-called "compatible" computers from other makers.

- Apple II, II+, IIe, and IIc™. This covers this family of Apple computers. It may also cover many so-called "compatible" computers from other makers.

- CP/M™. This is intended for any number of computers from many makers that use the CP/M operating system.

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Apple II, II+, IIe, and IIc are trademarks of Apple Computer, Inc.

CP/M is a trademark of Digital Research, Inc.

APPENDIX C

C.2 SYSTEM SETUP

The following programs are specific, therefore, configure your system to operate as shown below. (After you have practiced with the programs and feel comfortable with DM/PL, you can then change the system back to its original configuration.)

- On IBM equipment, interface the plotter to the serial port associated with the COM1: device name.

  On Apple equipment, use I/O slot #1 for the serial interface card.

  On CP/M-compatible equipment, interface the plotter to an I/O port and then define that port as the LST device. (All plot codes will then be routed to that device whenever a BASIC LPRINT statement is used.)

- Specify 2400 baud for the computer and the plotter.

- Set the data format for eight (8) data bits, two (2) stop bits, and no parity.

Instructions on how to setup the computer and plotter to operate at the parameters listed above are provided in each device's operator's manual.

C.3 SERIAL PORT INITIALIZATION

The computer serial port must be initialized before sending any plot data to the plotter. The procedures for setting these computer parameters depend upon the computer, as described below. For the IBM and Apple computers, this is done using a BASIC statement. For the CP/M computers, this is done using a system command before entering BASIC.

For the IBM PC:

10 OPEN "COM1:2400,N,8,2,CS,DS" AS #1

"OPEN COM1" opens the communications port for use. "2400" is the desired baud rate. "N" sets no parity. "8" specifies eight data bits. "2" specifies two stop bits. "CS" ignores the CTS (clear to send) line. "DS" ignores the DSR (data set ready) line. "#1" is the file number. The computer then treats serial port #1 as a file for input and output operations.

For the Apple II, II+, IIe, or IIc:

10 PRINT CHR$(4); "PR#1" This statement initializes the serial interface card in slot #1 for use. The baud rate, data bits, stop bits, and parity must be set with switches on the serial interface card in the computer.

For the CP/M computers:

Typically, the baud rate, data bits, stop bits, and parity for the serial port are configured using a system utility program. The serial port is then selected as the list device *before* entering BASIC. Refer to your CP/M manual.

C.4 PLOTTER INITIALIZATION

Verify that the following conditions exist before sending plot data to the plotter.

- The plotter is powered on and in remote mode.
- Paper (large) and pens are installed in the plotter.
- The plotter rear panel switches (or menu parameters) are set to match the host computer communications parameters.
- The host computer and plotter are properly connected with a data cable.

C.5 SIMPLE EXAMPLE

The following program listings show how to initiate the self test plot from a BASIC program running in the host computer. Note that the IBM and Apple programs initialize the serial port first (line 10). The DM/PL commands are treated as strings (line 20). ";:" selects the plotter, while "T" is the DM/PL command to perform the self test. (The self-test plot design produced by your plotter is illustrated in your plotter's operator's manual.)

For the IBM PC:

```
10 OPEN "COM1:2400,N,8,2,CS,DS" AS #1
20 PRINT #1, ";: T"
```

For the Apple II, II+, IIe, or IIc:

```
10 PRINT CHR$(4); "PR#1"
20 PRINT ";: T"
```

For the CP/M computers:

```
10 REM **PORT ALREADY INITIALIZED**
20 LPRINT ";: T"
```

The following program listings show how to initialize the serial port (line 10) and then make a simple DM/PL text string (line 20). The text parameters are explained in Section 2.6 of this manual. This program produces the plot "HOWDY!" at a 90° rotation.

For the IBM PC:

```
10 OPEN "COM1:2400,N,8,2,CS,DS" AS #1
20 PRINT #1, ";: A H P1,800,1800,S25 HOWDY!__"
```

For the Apple II, II+, IIe, or IIc:

```
10 PRINT CHR$(4); "PR#1"
20 PRINT ";: A H P1,800,1800,S25 HOWDY!__"
```

For the CP/M computers:

```
10 REM **PORT ALREADY INITIALIZED**
20 LPRINT ";: A H P1,800,1800,S25 HOWDY!__"
```

C.6 LITERAL AND VARIABLE EXAMPLE

The following program listings show how to handle plot data with both literal and variable values. Note that the IBM and Apple programs initialize the serial port before sending data (line 10). Also, the program prompts for a data input (line 20). If "100" is entered, then the plotter will produce a circle plot (see Figure C-1). Run the program three or four times and enter different variables for "R" (R = 125, R = 150, R = 175, etc.).

For the IBM PC:

```
10 OPEN "COM1:2400,N,8,2,CS,DS" AS #1
20 INPUT R
30 PRINT #1, "";: A H P1, CC 200,200,";R
```

For the Apple II, II+, IIe, or IIc:

```
10 PRINT CHR$(4); "PR#1"
20 INPUT R
30 PRINT ";: A H P1, CC 200,200,";R
```

For the CP/M computers:

```
10 REM **PORT ALREADY INITIALIZED**
20 INPUT R
30 LPRINT ";: A H P1, CC 200,200 ";R
```

FIGURE C-1
CIRCLE PLOT EXAMPLE

C.7 FOR/NEXT LOOP EXAMPLE

The following program listings show how to use both literal and variable plot data values within a for/next loop. Note that the IBM and Apple programs initialize the serial port before sending data (line 10). This program selects the plotter (line 20), then plots a series of overlapping circles using a for/next loop (lines 30, 40, and 50). The plot produced by this program is shown in Figure C-2.

For the IBM PC:

```
10 OPEN "COM1:2400,N,8,2,CS,DS" AS #1
20 PRINT #1, "";: A H P1,"
30 FOR X=210 TO 400 STEP 10
40 PRINT #1, "CC "; X; ",300,100,"
50 NEXT X
```

For the Apple II, II+, IIe, or IIc:

```
10 PRINT CHR$(4); "PR#1"
20 PRINT ";: A H P1,"
30 FOR X=210 TO 400 STEP 10
40 PRINT "CC "; X; ",300,100,"
50 NEXT X
```

For the CP/M computers:

```
10 REM **PORT ALREADY INITIALIZED**
20 LPRINT ";: A H P1,"
30 FOR X=210 TO 400 STEP 10
40 LPRINT "CC "; X; ",300,100,"
50 NEXT X
```

FIGURE C-2
FOR/NEXT LOOP PLOT EXAMPLE

APPENDIX D
DM/PL COMMAND INDEX

COMMAND (ASCII)	DESCRIPTION	PAGE NUMBER
A	Absolute Pen Positioning	2-6
CA	Arc Plot	2-18
CC	Circle Plot	2-18
CE	Ellipse Plot	2-19
CG	General Curve Plot	2-20
CS	General Curve Plot Terminator	2-20
D	Pen Down	2-9
EB	(Mode Two) Prompt Enable	2-5
EC	Coordinate Addressing	2-8
ED	Digitize	2-25
EF	Large Chart	2-1
EH	Small Chart	2-1
EL	Plot Pause	2-27
EM	Keyboard Mask	2-27
ER	Report	2-24
ET	End of Text	2-5
EU	UART Setup	2-27
F	Frame Advance	2-5
H	Home Position	2-8
L	Line Type	2-10
M	Marker Plot	2-22
M()	Extended Marker Plot	2-23
O	Set Plot Origin	2-9
P	New Pen	2-9
Q	Query	2-25
R	Relative Pen Positioning	2-7
S	Simple Text	2-11
S()	Extended Text	2-14
T	Plotter Test	2-26
U	Pen Up	2-9
V	Set Velocity	2-1
W	Set Window/Viewport Limits	2-2
X	Pass-Through Port Enable	2-26
Z	Plotter Reset	2-26
;:	Mode One Plotter Select	1-1
;:I	Mode Two Plotter Select	1-2
@	Plotter Deselect	1-4
x,y	Vector Move to Specified Coordinate	2-10
p	incremental +y	2-11
q	incremental +x,+y	2-11
r	incremental +x	2-11
s	incremental +x,−y	2-11
t	incremental −y	2-11
u	incremental −x,−y	2-11
v	incremental −x	2-11
w	incremental −x,+y	2-11
y	pen up	2-11
z	pen down	2-11

ABSOLUTE VECTOR PAIR: A coordinate set that references a set origin point to determine a position on a plane.

ACCURACY: The plotter's ability to produce a plot exactly to the dimensions specified by an input program or command.

ASCII: Abbreviation for American Standard Code for Information Interchange.

ASYNCHRONOUS SERIAL DATA COMMUNICATIONS: A serial I/O protocol in which each byte transmitted is self-sufficient and does not require a timing sequence.

BAUD RATE: The rate in bits per second at which information is transmitted over a serial link.

BUFFER: A storage circuit that compensates for differences in data flow between two computing devices.

BYTE: A sequence of adjacent binary digits (bits), operated upon as a unit in a computer.

COMMAND STRING: A collection of individual computer or peripheral commands that initiate or control predetermined operations.

COORDINATE SET (x,y): A pair of numeric specifiers that determine a single position on the plane of a coordinate axes system. A coordinate set can determine a position by either referencing a set origin point (absolute) or the position of the last vector pair (relative).

DATA: A general term for the numbers, letters, and symbols that serve as input or output for a computing device.

DIP (SWITCH): Abbreviation for dual in-line package.

DIGITIZER: An electronic device that converts graphic information into digital computer data.

HALF DUPLEX: A communication channel capable of transmission in both directions but in only one direction at a time.

HANDSHAKING: The process of transferring information between two devices in a synchronized manner at a rate acceptable to both devices (this process may be in either hardware or software).

HARDWARE: The electronic circuitry in a system.

HEXADECIMAL: A notation in the scale of 16, using alphanumeric digits 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, and F.

I/O: Abbreviation for Input and Output data.

IEEE-488 GPIB: Abbreviation for Institute of Electrical and Electronic Engineers #488, General Purpose Interface Bus.

INCREMENT: The smallest possible unit of plotter movement.

INTERFACE: The boundary between two devices.

MODEM PORT: A connector on the plotter for cable interface with a host computer.

POINT MODE: An operating mode of a digitizer where coordinate (x,y) data is digitized one point at a time upon local or remote command.

PROMPT CODE: A signal from a computer to a peripheral that instructs the device to execute the input data.

RAM: Abbreviation for Random Access Memory circuitry.

REPEATABILITY (%). The percent of fluctuation that will occur if the plotter produces the same plot design successively.

RELATIVE VECTOR PAIR: A coordinate set that references the location of the last vector pair to determine the next position on a plane.

ROM: Abbreviation for Read Only Memory circuitry.

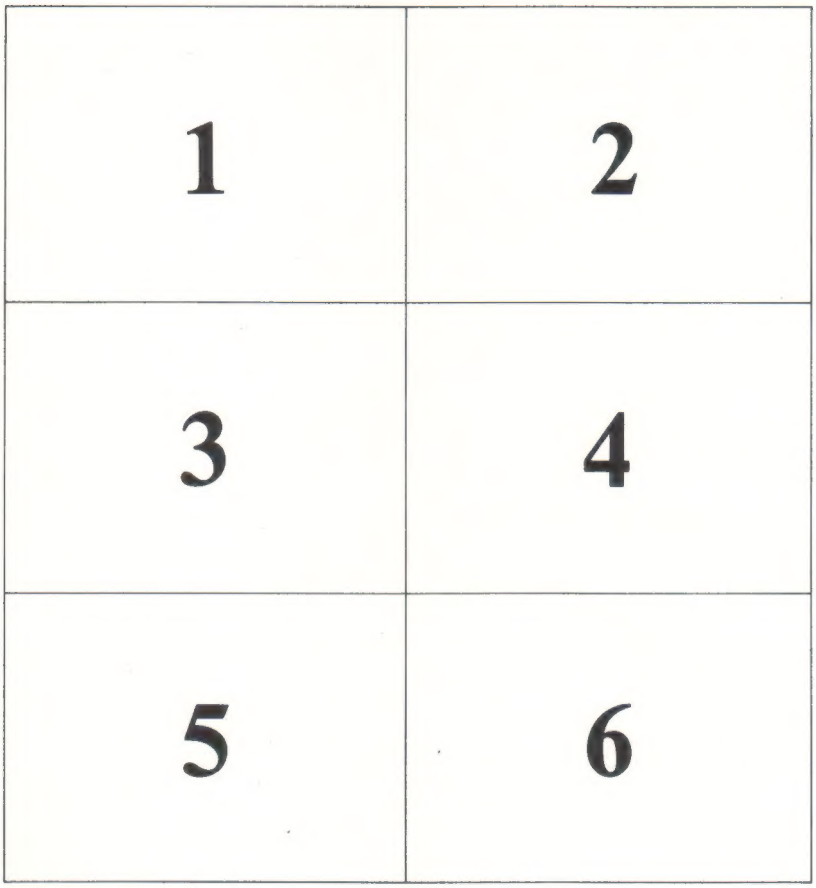
TERMINAL PORT: A connector on the plotter for cable interface with a CRT terminal.

USER ADDRESSABILITY: Defines the physical size of each user coordinate unit in inches or millimeters.

NOTES

NOTES

NOTES



ABOUT THE COVER

The colorful plots on the cover of this manual were chosen to show you the versatility of the DM/PL plotting language and Houston Instrument plotters. They represent just some of the types of application software available from many fine software companies that write programs usable with our equipment. Please note that use of these plots does not constitute a special endorsement by Houston Instrument; nor does omission of a sample plot by other companies infer a negative endorsement. (A listing of the companies that write software compatible with Houston Instrument products is available upon request.) The plots used on the cover are:

1. *DMP-29 Architectural Demonstration* by Houston Instrument. Drawn with a Houston Instrument DMP-29 plotter.

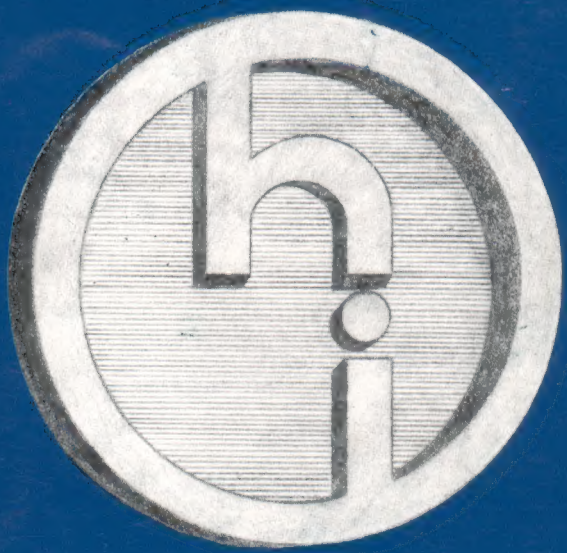
2. *Mapware* software by Computer Mathware. Drawn with a Houston Instrument DMP-29 plotter.

3. *PC Intergraphics* software by General Computer Technologies. Drawn with a Houston Instrument DMP-42 plotter.

4. *Robosystems CAD-1* software by Chessel Robocom. Drawn with a Houston Instrument DMP-42 plotter.

5. *Colorgraphy* software by Cactus Software. Drawn with a Houston Instrument DMP-29 plotter.

6. *Business Graphics System* software by Peachtree Software. Drawn with a Houston Instrument DMP-29 plotter.



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